RADIO'S LIVEST MAGAZINE

A GERNSBACK PUBLICATION

First Copy

Radio-Craft

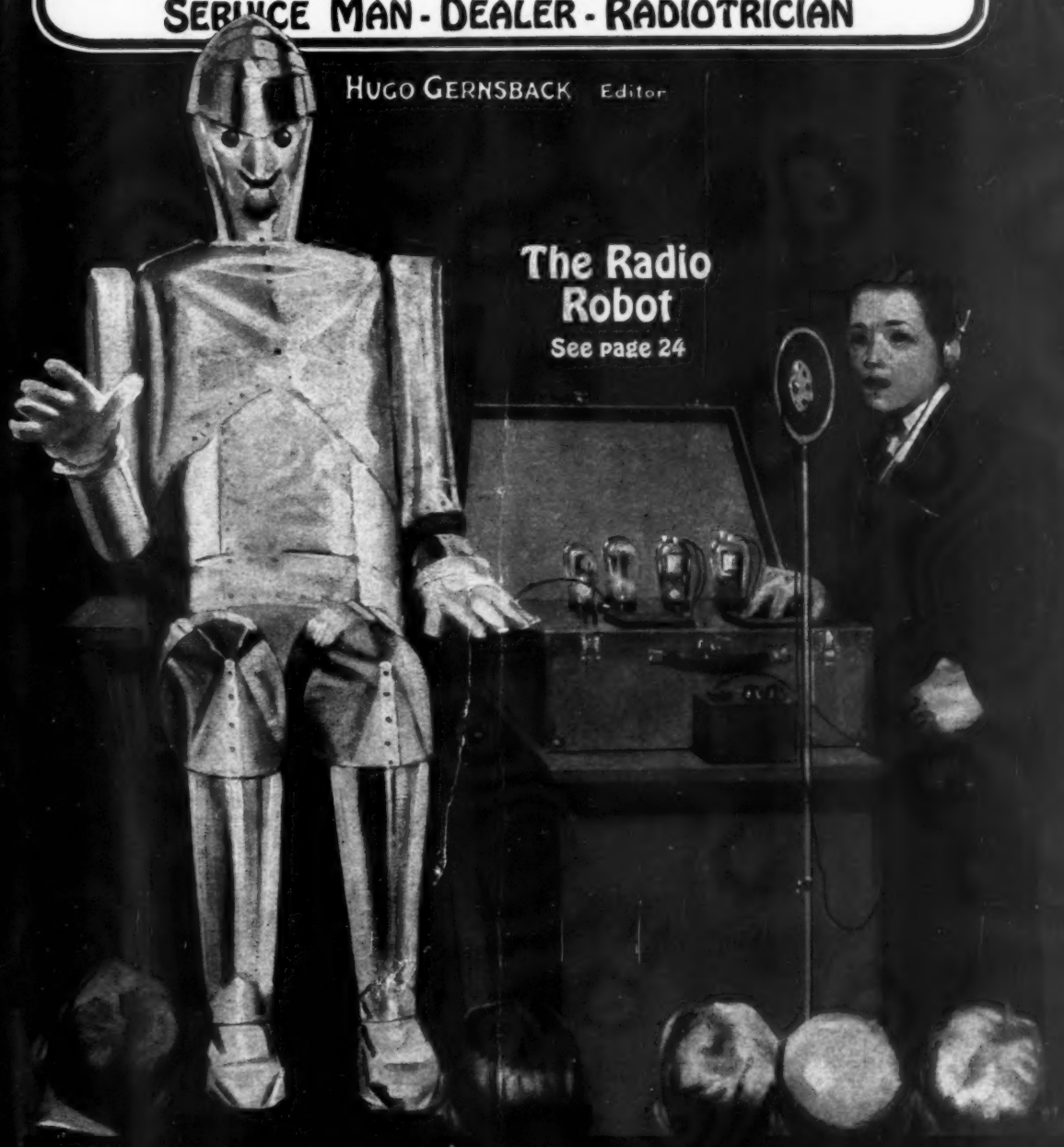
FOR THE

SERVICE MAN - DEALER - RADIOTRICIAN

July

25 Cents

HUGO GERNSBACK Editor



The Radio Robot

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What Radio Manufacturers Are Showing - The New Pentode Receivers - Home Recording

Latest Data for Service Men - Improving Short-Wave Reception - Rules for Coil Winding

VR v. 3 July 1931 June 1932

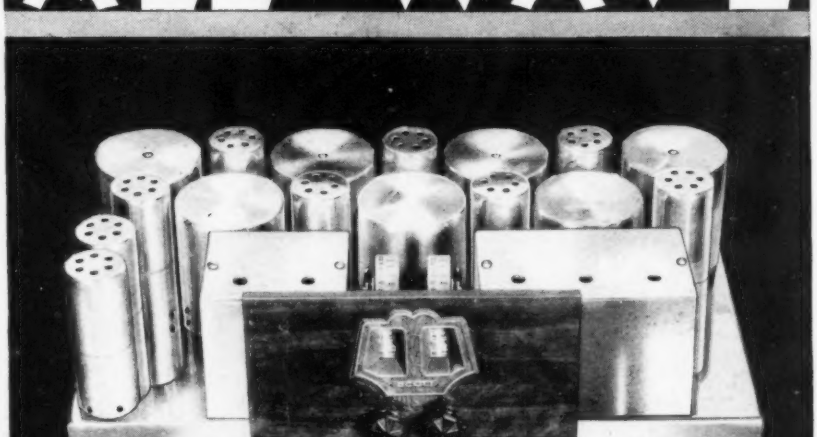
Rome and London come in like locals

JUST AS CLEAR - JUST AS LOUD

SCOTT ALL-WAVE SUPERHETERODYNE

A TRULY international receiver has been the desire of radio enthusiasts for years, and the hope of engineers since radio began. And what listener hasn't wished for a receiver that would bring him—not only the whole of North America—but the major stations on the other continents as well, and as easily? 1931 sees the perfected realization of all such dreams, in the new and genuinely excellent Scott ALL-WAVE Receiver.

The new receiver tunes from 15 to 550 meters. Actually—without exaggeration—it brings in Rome, London and many other foreign stations below 200 meters, just as clearly and with the same volume as a local broadcast. Grand Opera—the *real* Grand Opera, comes in direct from Rome to afford Scott listeners the musical thrill of a lifetime. And Big Ben, tolling off the hours in the House of Parliament in London, sounds as though it were right over head. Such reception is a REGULAR, DAILY event in homes equipped with the new Scott All-Wave Receiver.



New Standards for Short Wave Reception

The performance of the Scott All-Wave below 200 meters is not to be confused with the unsatisfactory short wave reception of the past. There are no sharp edges—no irritating squawks—no mushiness or other disturbing receiver noises to take from the thrill of listening to the other side of the world. The short wave broadcasters unroll their music, voice and song thru the Scott All-Wave, with the same liquid smoothness as those within the 200-550 meter band.

Credit goes to new kind of Intermediate Amplifier

The truly amazing performance—the unlimited range—the actual 10 kilocycle selectivity—all are due to the new type intermediate frequency amplification employed in this receiver. Never before thought of—never before attempted—this system of amplification accomplishes exactly what superheterodyne engineers have sought to achieve, ever since the advent of this admittedly superior receiving circuit.

GIVES A NEW MEANING TO "TONE"

The tonal reproduction of the Scott All-Wave is equally as refreshing as its sensitivity and selectivity. From a whisper to concert volume, every note—every delicate shading is faithfully reproduced. The push-pull audio amplifier employed gives results impossible to otherwise obtain.

suffice to express our confidence in the engineering and quality construction that makes Scott performance possible. So—we guarantee each Scott All-Wave for five years and agree to replace any part—free of charge—that fails to give perfect service within that time.

MAIL NOW

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Send me full details of the new Scott All-Wave Superheterodyne. I am a Dealer ☐ Set Builder ☐ Service Man ☐ Radio Fan ☐

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5-YEAR GUARANTEE

To simply say that we believe the new Scott All-Wave to be the finest receiver ever built, does not

Make the SCOTT ALL-WAVE Prove Itself to You

Decide right now to have the ultimate in radio. Plug the new Scott All-Wave into a base board socket in your own home. Tune in Rome—tune in London—tune in Chelmsford—listen to Sydney, Australia—to Buenos Aires—to Bogota, Colombia—enjoy short wave foreign stations to your heart's content. Then step thru the broadcast band for the domestic stations. You'll find them all on dial, and all with far more volume than you can ever use. The price of the new Scott All-Wave is amazingly low. Write for full particulars at once.

SCOTT TRANSFORMER CO.

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Tech.

Train with R.T.A. for Radio Service Work

Important and far-reaching developments in Radio create sudden demand for specially equipped and specially trained Radio Service Men.

With this Radio Set Analyzer (sent to every Member) You Can Earn $3.00 an hour

THOUSANDS of skilled Radio Service Men are needed now to service all-electric sets. By becoming a certified R. T. A. Service Man, you can earn $3.00 an hour full time or spare time, and fit yourself for the big-pay opportunities that Radio offers.

We will quickly give you the training you need to qualify as a Radio Service Man . . . certify you . . . furnish you with a marvelous Radio Set Analyzer. This wonder instrument, together with our training, will enable you to hold your own with experts who have been in the radio business for years. With its help you can quickly diagnose any ailing Radio set. The training we give you will enable you to make necessary analysis and repairs.

Serving as a "radio doctor" with this Radio Set Analyzer is but one of the many easy ways by which we help you make money out of Radio. Wiring rooms for Radio, installing and servicing sets for dealers, building and installing automobile Radio sets, constructing and installing short wave receivers . . . those are a few of the other ways in which our members are cashing in on Radio.

As a member of the Radio Training Association, you receive personal instruction from skilled Radio Engineers. Upon completion of the training, they will advise you personally on any problems which arise in your work. The Association will help you make money in your spare time, increase your pay, or start you in business. The easiest, quickest, best-paying way for you to get into Radio is by joining the Radio Training Association.

This amazing Radio Set Analyzer plus the instructions given you by the Association will transform you into an expert quickly. With it, you can locate troubles in all types of sets, test circuits, measure resistance and condenser capacities, detect defective tubes. Knowing how to make repairs is easy; knowing what the trouble is requires expert knowledge and a Radio Set Analyzer. With this Radio Set Analyzer, you will be able to give expert service and earn $3.00 an hour. Possessing this set analyzer and knowing how to use it will be but one of the benefits that will be yours as a member of the R. T. A.

No-Cost Membership Plan Now Open

The No-Cost Membership Plan enables you to secure a membership without cost. The training and the valuable Radio Set Analyzer can be yours! Now is the time to prepare to be a Radio Service Man! By the time you're ready, demand will exceed supply. Bigger salaries, rapid promotion, bigger opportunities! For the sake of extra money made in your spare time, bigger pay, a business of your own, a position with a future, get in touch with the Radio Training Association at once. Send for No-Cost Membership Plan, and FREE Radio Handbook that will open your eyes as to what Radio has in store for the ambitious. Don't wait! Don't delay! Get started now!

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City..... State.....

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Radio-Craft

FOR THE SERVICE MAN · DEALER · RADIOTRICIAN

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VOLUME III
NUMBER 1

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In Forthcoming Issues

MODERNIZING THE OLD SUPERHETERODYNES, by F. L. Sprayberry. No article we have published has attracted more requests for personal information than Mr. Sprayberry's explanation of his way of adapting the Radiola "28" to 2-volt tubes. He will write also on the earlier models, "25" and "812."

THE RADIO-CRAFT PENTODE PORTABLE. In every country of Europe, the portable radio receiver is a favorite type; it has never reached any such vogue here—possibly because of the very relative nature of its "portability." The new pentode has made possible a very light, compact, inexpensive model of good output, which will be described. It is a development of RADIO-CRAFT laboratories.

APPLICATIONS OF THE PENTODE, by C. E. Denton. This article will be devoted to the practical side of the problem. It will contain curves, data, and circuits for the use of the pentode to best advantage; either for the construction of a new receiver, or the modernization of the older models.

IMPROVING RESULTS WITH SHORT-WAVE ADAPTERS, by Lewis Winner. A discussion of the principles to be followed in obtaining good results on short waves with adapters (or converters) used in connection with broadcast receivers. This article will show many where their mistakes have been made, and enable others to make good short-wave reception better.

RADIO-CRAFT is published monthly, on the fifth of the month preceding that of date; its subscription price is $2.50 per year. (In Canada and foreign countries, $3.00 a year to cover additional postage.) Entered at the postoffice at Mt. Morris, Ill., as second-class matter under the act of March 3, 1879. Trademarks and copyrights by permission of Gernsback Publications, Inc., 98 Park Place, New York City.

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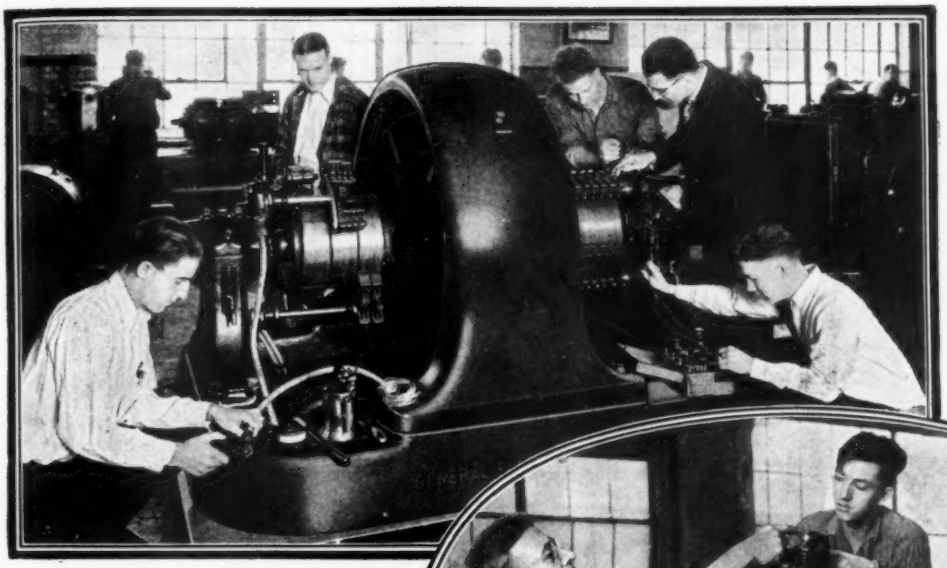

Coyne students getting actual experience on one of my big synchronous converters!

One of my Instructors explaining the operation of a radial airplane engine.

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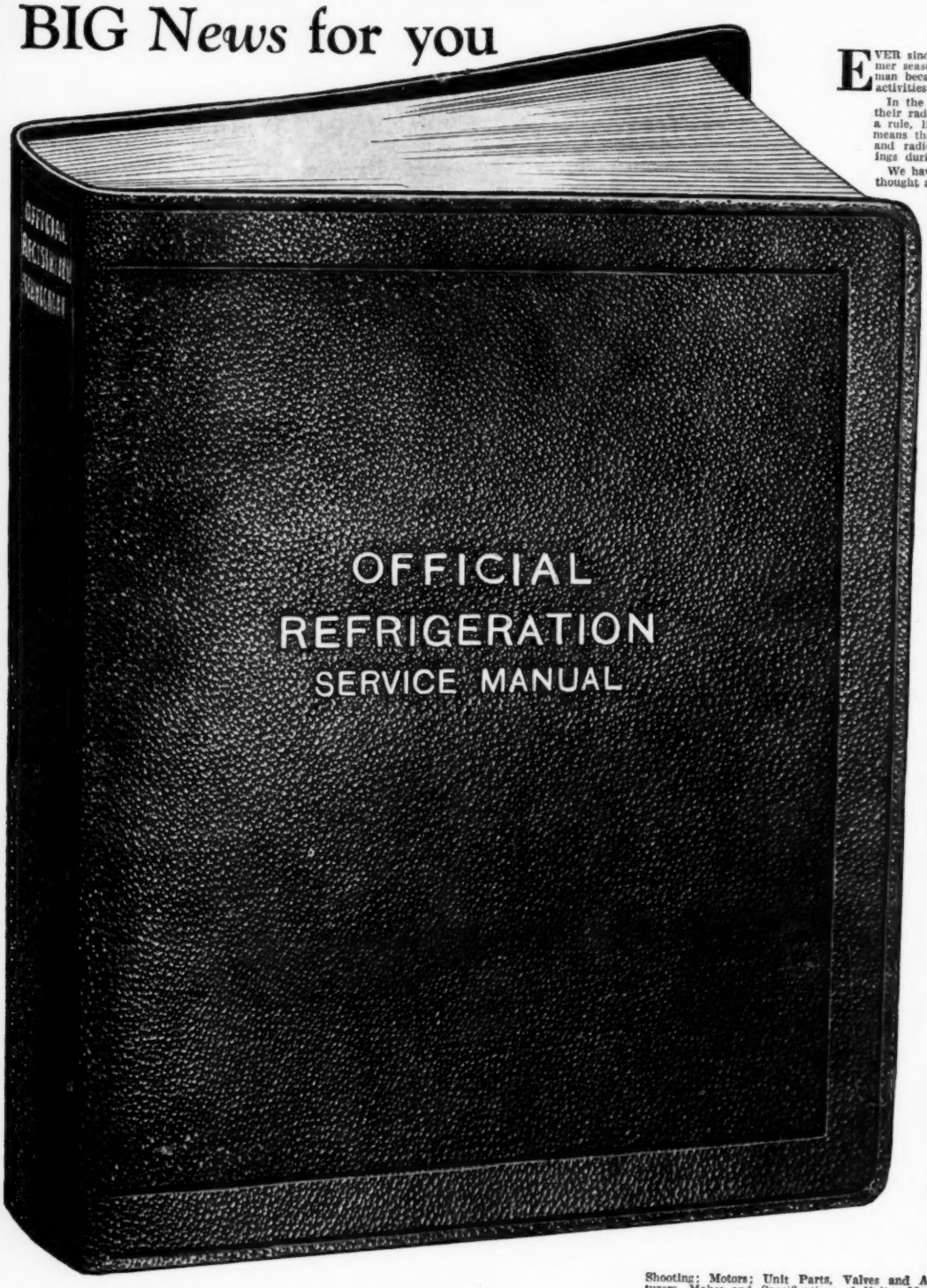

EVER since the advent of radio, the summer season has been a curse to the radio man because that is the time when radio activities are at their lowest.

In the summer time, people do not use their radio sets so much and there is, as a rule, little servicing to be done. This means that the average radio service man and radiotrician finds pretty slim pickings during the summer months.

We have given this problem considerable thought and for over a year worked quietly on the problem; and **from now on every radio man, service man and radiotrician will have a steady income all the year around, incredible as this may seem.**

The idea of radio people servicing refrigeration units is self-evident and the thought has occurred to perhaps untold thousands of radio men ever since electric refrigeration started. Yet nothing was done, because the average radio man knows little or nothing about refrigeration. Our survey of the field convinces us that, compared with servicing a radio set, the servicing of a refrigerator is absurdly simple, once you get the hang of it; and that is exactly why **the OFFICIAL REFRIGERATION SERVICE MANUAL** is going to be a side-partner to the OFFICIAL RADIO SERVICE MANUAL, with which you are well acquainted.

When you are called in to service a radio set, it is easy to find out if your customers own a refrigerator. If they do, you can now tell them that you can service the refrigerator as well. Place your card somewhere near the refrigerator so that, if trouble comes, you will be called in to fix it.

From whatever point you look at it, you will make money. And don't ever lose sight of the fact that refrigerators usually need servicing in the summer time and that **it is here that you will get a new and extra income.**

But don't take our word for all this. Study the situation yourself and see if we are not right. Look around in your locality and find out how many refrigerators there are. At the present time the servicing of these refrigerators goes to other trades when this business might just as well belong to you.

So we say to you, why not go into the refrigeration servicing business at once? Remember, there is big money in it and the refrigeration business is growing enormously every year; and it won't be very long before there will be more refrigerators than radios.

The OFFICIAL REFRIGERATION SERVICE MANUAL has been edited by L. K. Wright, who is an expert and a leading refrigeration authority. He is a member of the American Society of Mechanical Engineers, American Society of Refrigeration Engineers, The National Association of Practical Refrigeration Engineers, etc.

The new Manual, as you will see from the photographic reproduction, is the same size as our OFFICIAL RADIO SERVICE MANUAL. It will be 9 x 12 inches, and will contain at least 400 pages—loose-leaf, bound in leatherette, gold-stamped cover; in fact, it is a gold mine of information on the entire art of refrigeration.

Here are the chapter contents: Preface; Introduction; History of Refrigeration; Fundamentals of Refrigeration; Description of All Known Types of Refrigeration; Service Tools and Shop Equipment; Trouble Shooting; Motors; Unit Parts, Valves and Automatic Equipment; Manufacturers, Makes and Specifications of Units; Manufacturers of Cabinets.

Every page is profusely illustrated; every refrigerator part is explained; diagrams are furnished of every known machine; special care is given to the servicing end, of course; all the tools needed are illustrated and their use explained; there are trouble shooting charts, and other service data.

This by no means exhausts the contents of the book, and it would take much more space to give you all of the details. Last year, when we brought out the OFFICIAL RADIO SERVICE MANUAL, we made a special pre-publication offer to our friends, which actually saved them thousands of dollars. We are now giving you the same chance again for a very short time.

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The regular price of the OFFICIAL REFRIGERATION SERVICE MANUAL is $5.00 after it is published. To you, the book will be sold at $3.50 prepaid if you send in your order at once before the publication of the book. Please use the coupon. The whole book is now ready for the printers and we are putting on the last finishing touches. It will be in the printer's hands in a few weeks. Once the OFFICIAL REFRIGERATION SERVICE MANUAL is issued, you know from experience that we cannot allow any price reduction and, the instant the book comes off the press, the price will be $5.00.

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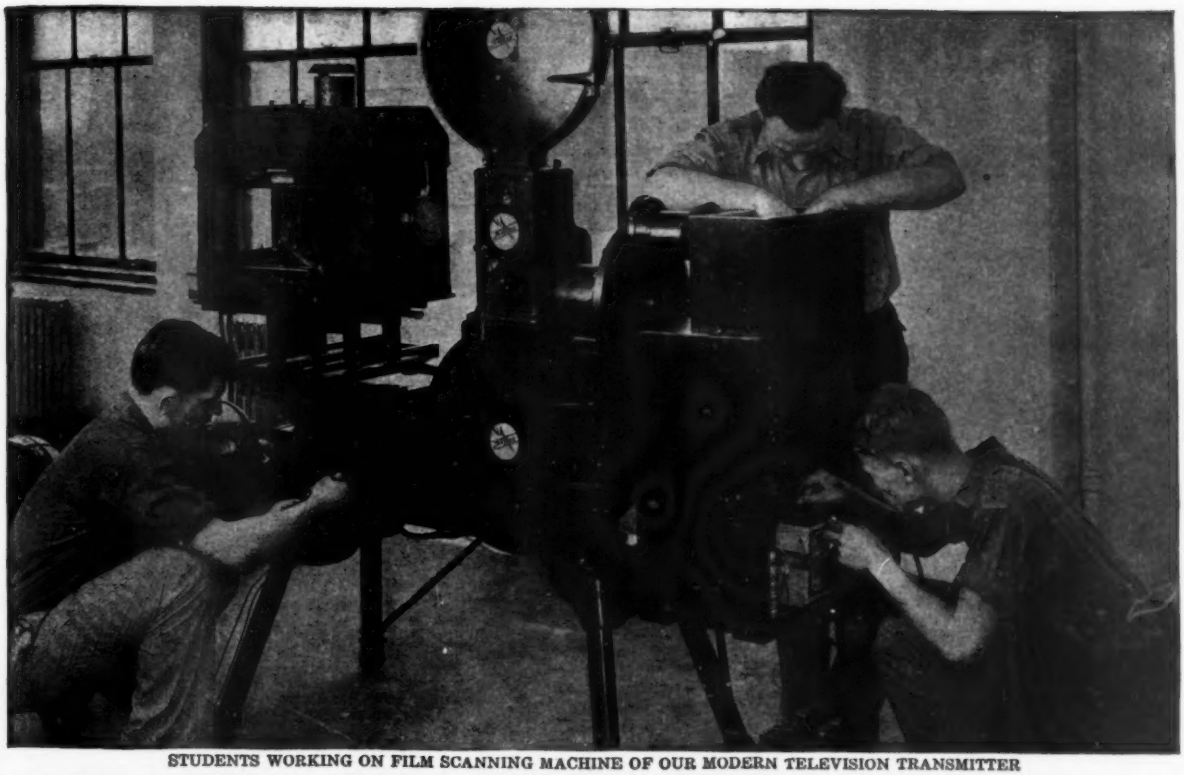

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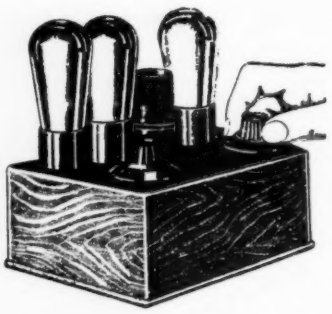
SHORT WAVES *with a Converter!*



The Model PR-3FS Short-Wave Converter that is, in fact, an all-wave converter, as it enables also the reception of broadcast frequencies. The range is 25 to 600 meters, so you are sure to cover the television band, too.

WITH high-gain radio frequency amplifiers characterizing experimenters' broadcast receivers today, and audio amplification remarkably faithful, it is convenient, economical and easy to tune in short waves and television with a converter. In that way you use your entire broadcast receiver just as it is, and besides the television band, tune in other short waves. The range is 25 to 600 meters, when the broadcast set is worked at a high frequency, around 1,500 kc.

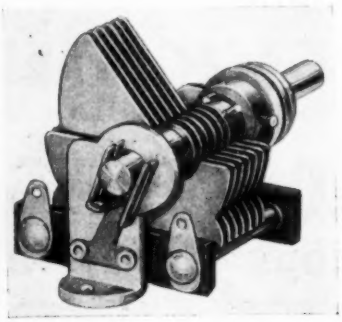
The converter illustrated is model PR-3FS and has a filament transformer built in. There are only four external connections to make, and one of these is to a positive B voltage, 50 to 180 volts, taken from the receiver. If you have a screen grid set you may take this voltage from the screen of a radio frequency tube, by looping the bared end of the B plus lead and slipping the screen prong of the tube through the loop before reinserting the tube in the set.

The converter uses three 227 tubes and plug-in coils of the tube base type. There is an AC switch built in, but there is only one tuning dial (at right). The condenser is the new Hammarlund Junior Midline of .0002 mfd. capacity.

This short-wave converter has proved highly satisfactory, developing great sensitivity and enabling the penetration of great distances. There are no body capacity, no squealing, no squawking and no tricky tuning.

By all means provide yourself with the complete parts for this dandy converter, as specified by Herman Bernard, the designer.

▽ ▽



The new Hammarlund Junior Midline Short-Wave Condenser, capacity .0002 mfd. The rotor plates turn in a diameter of only 2 inches, while the total frame depth is only 1⅝ inches. So this is an extremely compact condenser, made by one of the foremost condenser manufacturers in the world. It is our Model No. PR-H-20, made specially for us.

THE newest condenser to come from the laboratories of the Hammarlund Manufacturing Co. is the Junior Midline, made especially for us, and designed for highest grade short-wave performance. The capacity is .0002 mfd. and the midline tuning characteristic prevails. Single hole panel mount, in a ⅜-inch hole (with option of sub-panel mounting by built-in brackets); end stop provision at both extremes; rigid plate assembly and the fine workmanship of Hammarlund mark this compact condenser. The overall depth of the frame is 1⅝ inches, while the rotor plates turn in a diameter of only two inches. This condenser, our Model PR-H-20, is a superb product, in line with the modern vogue of compact parts.

▽ ▽

PRECISION short-wave plug-in coils, three coils to a kit, not counting as a coil the movable tickler. Used with .0002 mfd. for tuning, this kit of coils affords coverage of from 15 to 160 meters. These coils are wound on 97% air dielectric and are precision, de luxe products. A receptacle base, on which the adjustable tickler is mounted, is supplied with each coil kit. This kit is our Model No. PR-AK-1 and represents the pinnacle of short-wave plug-in coil achievement. It is for short-wave receiver circuits.

▽ ▽

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RADIO WORLD, now in its *ninth* year, is the first and only national radio weekly, and publishes the latest, up-to-the-second news of circuits, both of kit types and of 1931 commercial receivers, as well as news of happenings in the broadcasting field. Lists of broadcast and short-wave stations, including television stations, are published regularly. You get your information weekly—which means quickly—and you get it accurately, so be sure to become or remain a subscriber for RADIO WORLD. We are able to offer now premiums especially attractive to short-wave experimenters, and ask you to make your choice from the parts offered on this page. When ordering, please use coupon.

The regular subscription rates are: $6 for one year, 52 issues, one each week; $3 for 6 months, (26 weeks); $1.50 for three months, (13 weeks); $1 for 8 weeks; 15c per single copy.

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145 West 45th St., New York, N. Y.

Enclosed please find:

☐ $12.00 for two years' subscription (104 issues) for RADIO WORLD at the regular rate. Please send as a premium all parts to build the Short-Wave Converter, including filament transformer and 5½x7-inch cabinet, but not including tubes. This is your Model PR-3FS.

☐ $6.00 for one year's subscription (52 issues) for RADIO WORLD. Please send the Short-Wave Coil Kit as a premium, your model PR-AK-1, consisting of three plug-in coils and base receptacle.

☐ $3.00 for six months' subscription (26 issues). Please send the Hammarlund Condenser, PR-H-20.

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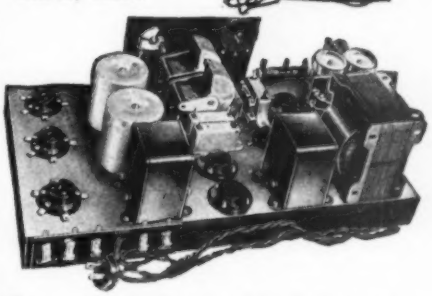
You can build over 100 circuits with these outfits. You build and experiment with the circuits used in Crosley, Atwater - Kent, Eveready, Majestic, Zenith, and other popular sets. You learn how these sets work, why they work, how to make them work. This makes learning at home easy, fascinating, practical.

Back view of 5 tube Screen Grid A. C. tuned Radio frequency set—only one of many circuits you can build with my outfits.



Here's Proof

If you are earning a penny less than $50 a week, send for my book of information on the opportunities in Radio. It is free. Clip the coupon NOW. Why be satisfied with $25, $30 or $40 a week for longer than the short time it takes to get ready for Radio.

Radio's growth opening hundreds of $50, $75, $100 a week jobs every year

In about ten years Radio has grown from a $2,000,000 to a $1,000,000,000 industry. Over 300,000 jobs have been created. Hundreds more are being opened every year by its continued growth. Men and young men with the right training—the kind of training I give you—are needed continually.

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Broadcasting stations use engineers, operators, station managers and pay $1,800 to $5,000 a year. Manufacturers continually need testers, inspectors, foremen, engineers, service men, buyers, for jobs paying up to $15,000 a year. Shipping companies use hundreds of Radio operators, give them world wide travel at practically no expense and a salary of $85 to $200 a month. Dealers and jobbers employ service men, salesmen, buyers, managers, and pay $50 to $100 a week. There are many other opportunities too. My book tells you about them.

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J. E. SMITH, President
National Radio Institute Dept. 1GX
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Some of the features in the third Supplement

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JULY
1931
VOL. III—No. 1

Radio-Craft
FOR THE SERVICE MAN · DEALER · RADIOTRICIAN

"Takes the Resistance Out of Radio"

HUGO GERNSBACK
Editor

Editorial Offices, 96-98 Park Place, New York, N. Y.

The Radio Dollar

By HUGO GERNSBACK

IN a time of rapid industrial changes, we may easily fail to recognize how thorough these changes are and, also, how revolutionary in many respects is the fall of prices.

During the present depression, all industries have, of course been affected to a marked degree; but there is, perhaps, no other industry that has been affected so vitally as radio. It is noteworthy that the downward price movement in radio has exceeded that of most other industries.

Few people realize that the radio dollar of 1924-26, when radio activities were at their peak, is wortn less than 25c compared to today and it is probable that the figure of 25c on the dollar is quite high as radio goes today. It can at best only be an approximation or an average; but you can pick out any amount of items where the radio dollar of 1924 is worth considerably less than 25c today. Or to put it in another way, because of the lower prevailing prices, the *purchasing power* of the radio dollar today is therefore $4—compared to the 1924 dollar.

Take, for instance, the receiving tubes. In 1924 the average price of tubes was around $4.00 or $5.00 apiece; while today, the average price of tubes (disregarding list prices, and using average prices in the open market) is about 60c.

Take the average radio set in 1924; the prices then were around $150.00 to $200.00; whereas today, the average price—when the midget sets are figured in—is somewhat less than $50.00 if we figure the set stripped, and without tubes. We must also figure that in 1924 sets were sold for $150.00 to $200.00 without a loud speaker; but today practically all sets come with loud speakers, and the purchasing value of the 1931 dollar therefore, is proportionately higher.

There is not a single radio item today that cannot be bought at prices that are exceedingly low—if you compare them with those prevailing in 1924—whether it be standard merchandise put out by a reputable house, or surplus merchandise thrown on the market for what it will bring. No matter how you figure it, the radio dollar today in purchasing power is bigger than it ever was.

In many respects, it may be said that this is the radio millennium, so far as prices are concerned; and it is doubtful indeed if we shall ever see such low prices again.

The reason, of course, is that today the basic industries from which the radio industry derives its raw materials are all operating at exceedingly low costs, and in many cases even below cost.

Take, for instance, such an item as copper, which enters largely into the production of every radio set; it is today selling actually lower than it has done in the past 35 years. The chances are (going by averages), that copper will not sell so low again for many years to come. The same thing is true in a proportionate degree of all other materials. Many industries, in ruinous competition, are selling their product actually at a loss. Copper, for instance, which costs more than 11c a pound to produce, on the average, is sold at 9c. That means, that the public today is virtually getting radio merchandise at less-than-cost prices; which condition, in the very nature of things, cannot last forever.

The same idea is carried further into the finished product as well. Thus, for instance, radio tubes also are being sold at lower prices today than they probably will be for a generation to come. The reason here is a price war between several of the large tube interests, in order to exterminate a number of smaller concerns. After this has been accomplished, the chances are, the prices will be higher again.

The same situation also prevails in the radio set industry; and those who can see the handwriting on the wall, realize that, even today, only a comparatively few radio set manufacturers are left compared to the peak of 1926-1929. After the process of elimination is over, the chances are that the present depression will be over as well, and higher prices will prevail for both reasons.

These are the heyday bargain days of radio. Ten years from now, we shall look back with wonder at what we were able to buy with the radio dollar in 1931, and we will marvel how it was done.

The intelligent radio man of today appreciates this situation, and is making the best of it by stocking up with the necessary material that he will require for some months to come. He need have little misgiving that he is making a mistake by paying too much. As I have often said before, there are still increasing opportunities, to make money in radio, for the wide-awake radio man who is alive to the possibilities that are open to him today.

FIRST!

FOR the past two years, RADIO-CRAFT has brought to its readers FIRST, all new radio developments, with practically no exception. In many cases, the new inventions and developments are published from two to four months ahead of other radio publications.

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Short-Wave Prospecting

If you wish to get the latest radio developments FIRST, read RADIO-CRAFT.

A New All-Wave Oscillator for Modern Servicing

With features of special value in superheterodyne work

By H. G. CISIN, M.E.

ULTIMATE simplicity distinguishes the new Supreme "Model 70" modulated oscillator; by means of an ingenious circuit arrangement, both the intermediate and the broadcast bands, from 90 to 1500 kilocycles, are covered with a *single set of inductance coils* and tuning condenser. One '30 tube is used in the instrument, and may be supplied with current from dry-cell batteries (the shielded case provides room for the batteries); or it may be connected to the light-line. An output meter (which is also combined with an ohmmeter, for measuring all resistances up to 1 megohm) is furnished; but the oscillator may be obtained without the output meter by those who already have an output meter, or a set analyzer containing one.

A dummy antenna enables the oscillator to be coupled to the radio receiver under test; the output from the oscillator being under control by a tapered variable resistor. Complete shielding eliminates the possibility of picking up from the oscillator energy which has not passed through the dummy antenna.

A more detailed analysis of the instrument may be obtained by reference to the diagram. It will be noted that the familiar Hartley oscillator circuit is employed, including two inductance coils L1 and L2 tuned by the variable condenser C1. The plate current of the tube is fed through the R.F. choke RFC-1; the feedback effect taking place through the blocking condenser C2. The oscillatory circuit L1-L2-C1 covers a band of *fundamental* frequencies between 90 and 250 kilocycles. For all higher frequency-bands, the *multiples*, or *harmonics*, of the fundamental frequencies are employed. By this means, frequencies up to 1500 kilocycles are generated in the single tuning circuit without the use of complicated switching arrangements. Complete calibration charts are supplied, enabling the operator to determine the frequency with an accuracy within one-half of one per cent.

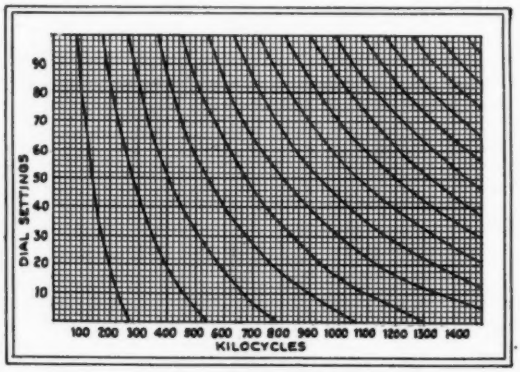
With this wide tuning range, the instrument is adapted to all commercial intermediate frequencies, as well as to other intermediate frequencies between 90 and 550 kilocycles which may be employed in future superheterodynes; thereby eliminating the possibility of the instrument's becoming obsolete.

Operation of the Oscillator

In the grid circuit of the tube is placed a grid condenser, C3, and grid-leak resistors R2 and R3; R2 may be short-circuited by means of the switch S1. With the switch open, "grid-leak modulation" takes place; that is, the grid condenser charges and discharges at an audible frequency and modulates the oscillator output. (The tone's slight variation over the tuning range is an index of the tuning multiple.—*Tech. Ed.*) This method of modulation is used only when the oscillator is supplied with battery current or current from the 110-volt D.C. line. When the A.C. line is employed, the output is automatically modulated by the frequency of the supply voltage; in this case, the switch S1 may be closed. Obviously, it will work on an A.C. line of any commercial frequency.

The Supreme "Model 70" oscillator in its carrying case; with the output meter at the left.

Coil L3, shunted by the variable resistor R1, serves as a dummy antenna, coupled to the main oscillatory coils, from which it picks up energy to be delivered to the set under test. The fixed condensers C4, C5 and C6 isolate from the oscillator the dummy antenna's grounded connection to the set.



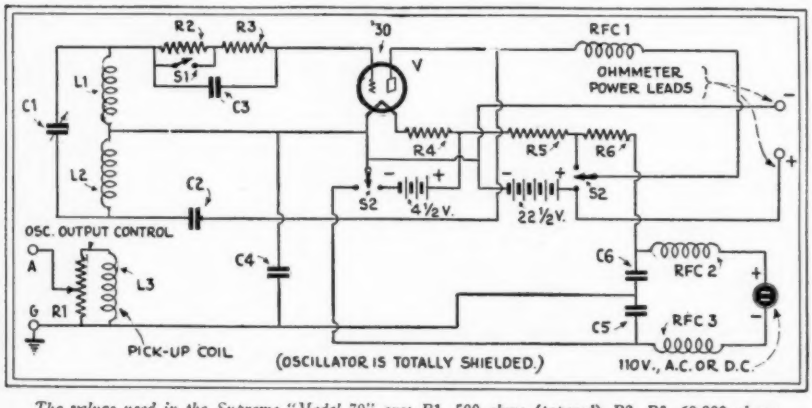
The curve at the very left is the fundamental frequency of the oscillator; its 15 harmonics, in their order, cover the whole range of servicing. The difference between two oscillator settings immediately indicates the position of one frequency adjustment, with relation to the other.

By means of a single toggle-switch (shown in the diagram as the two switches S2) the oscillator can be changed over immediately from battery to lamp-socket operation, or vice versa. For battery operation, a single 4½-volt "C" battery, and a 22½-volt "B" battery or the equivalent, are employed. These fit within the shielded oscillator case in compartments provided.

For socket power operation, a detachable cord and plug are provided. From the 110-volt D.C. line it is necessary to have the correct *polarity;* it may be necessary to reverse the plug if it is placed in the lamp socket the wrong way at first. If a 220-volt power supply system is encountered, the oscillator may be operated in series with a 2000-ohm, 10-watt, resistor.

The R.F. chokes, RFC2 and RFC3 are placed in the power-line circuit as shown; these prevent the radio-frequency energy from the oscillator from leaking out into the power line and interfering with measurements on the set. In general service practice, the 110-volt A.C. or D.C. line should be used; the batteries being employed only where power is not available. In this way the life of the batteries is prolonged, and the cost of operation becomes negligible.

The resistor R4, which cuts the 4½-volt battery's voltage down to the required 2 volts for the type '30 tube, has a value of



The values used in the Supreme "Model 70" are: R1, 500 ohms (tapered) R2, R3, 60,000 ohms; R4, 42 ohms; R5, 300 ohms; R6, 1591 ohms. Condenser C1, .0005-mf.; C2, C3, C4, C5, C6, 0.01-mf. L1-L2 have a total inductance of 6.2 millihenries. Opening S1 gives A.F. modulation. (Latest models have two more filter condensers across the light-line, outside the chokes.)

about 42 ohms. The resistors R5 and R6, together with R4, cut a 110-volt supply down to the correct value. The 22½-volt plate supply is taken from the line voltage at the connection between the resistors R5 and R6. It will be observed that no filtering is employed; as the pulsating or alternating line voltage is used for modulation purposes.

Extra terminals are provided for the 22½-volt battery on the panel of the instrument; so that this battery may be used in connection with the ohmmeter for measuring resistances. These terminals are clearly shown in the diagram.

The output-ohmmeter provided with the instrument is a very ingenious combination of a D'Arsonval meter movement with a full-wave copper-oxide bridge rectifier. An arbitrary range is provided for the radio output indicator, together with an accurately-calibrated ohmmeter, ranging from 0 to 1 megohm. This will indicate circuit continuity of even higher resistance values.

The Supreme portable copper-oxide-rectifier meter used with the "Model 70" oscillator; its circuit appears on page 49.

The mechanical construction has been designed for maximum compactness, light weight, durability, appearance and simplicity of operation. The black bakelite panel, with verichromed markings, presents a pleasing appearance. It is mounted on an aluminum plate which fits into a cast aluminum tray; giving complete shielding and great mechanical strength. A hardwood carrying case (furnished separately) may be used for transporting the oscillator and output meter. The control dial is of special design, affording a positive vernier action, which is necessary for fine settings.

Practical Applications

The busy Service Man is called upon to service all kinds of receivers. The more complicated superheterodynes, which are now becoming very popular, require very accurate adjustments, to give full satisfaction. Hence, the use of a service oscillator of simple design, but very flexible in its applications, is essential; while a thorough knowledge of its use is an important factor.

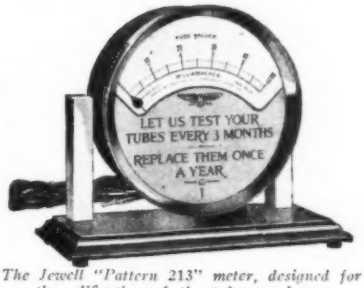
To use the oscillator, first connect the two output terminals of the oscillator (marked A and G in the diagram) to the antenna and ground binding posts of the set under test. Special marked leads for this purpose are provided with the instrument.

The output meter is then connected to the set output. Special leads, equipped with

(*Continued on page 49*)

Latest Testing Equipment for Bench and Kit

What manufacturers have developed recently for the Service Man



The Jewell "Pattern 213" meter, designed for the edification of the tube purchaser.

COUNTER DEMONSTRATION CHECKER

SALESMANSHIP, as well as technical accuracy, dictated the design of the tube checkers shown, which their maker markets as "Tube-Sellers." While a small meter shows the tube salesman the readings, the big demonstration meter facing the customer presents them in conspicuous and confidence-inspiring fashion. Psychology as well as precision is evident here. The big meter is "Pattern 213," and the combination shown as "Pattern 219" includes a counter-type tester with pre-heater, rotary filament switch, and connections for the newest pentodes.

Left, a set-up a tester and large meter for counter use; the combination is Jewell "Pattern 219."

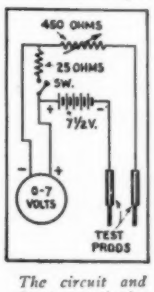
Right, the new Weston "Model 571" output meter, a precision instrument for all types of servicing.

(*Jewell El. Instrument Co., Chicago, Ill.*)

CONTINUITY METER

FOR custom set builders, handling receivers of specially high quality, the manufacturer of the latter has produced the equipment shown in the illustration, as a compact piece of equipment for checking the work. A battery is included, together with a meter, variable resistor and test prods; circuits may be quickly tested, resistances determined, and the assembly proved before delivery is made.

(*Scott Transformer Co., Chicago, Ill.*)



The circuit and outward appearance of the Scott continuity meter, useful for many purposes.

OUTPUT METER

COMPARISONS of output, as well as checking and balancing of circuits, not only in receivers, but in public-address and projection equipment, are facilitated by the use of the device shown. It has five ranges: 1.5, 6, 15, 60 and 150 volts, A.C., which are obtained by the range-selector switch below the dial. The non-inductive impedance of 4,000 ohms is constant for all ranges. The instrument may be connected across the output of a receiver: but, if it replaces a voice coil directly, must be shunted by a resistance approximating that of the coil. It is 5½x3⅝x2⅛ inches over all, and weighs about 26 ounces.

(*Weston El. Instrument Corp., Newark, N. J.*)

"DEADLINE" TUBE CHECKER

BY the use of a particularly "dead-beat" moving-coil type of test meter, there has been developed for the Service Man and tube salesman a particularly fast-working test instrument. The name "Deadline" is derived from the graph that accompanies each instrument, on which is indicated the "life expectancy" (to borrow an underwriter's term) of the tube under test; those reading below the line being electrically "dead."

The circuit design makes it possible to determine whether a tube will be noisy in operation; and whether its elements are

(*Continued on page 43*)

PHILCO "MODELS 111" AND "111A" SUPERHETERODYNE RECEIVERS

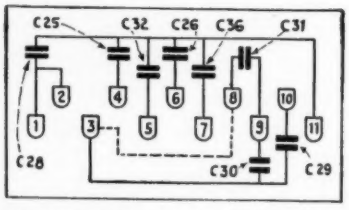
The fundamental circuit of the above listed Philco receivers, manufactured by the Philadelphia Storage Battery Co., Philadelphia, Pa., is the subject of this Data Sheet; with particular reference to the Model 111 set.

Available constants are listed, as follows:

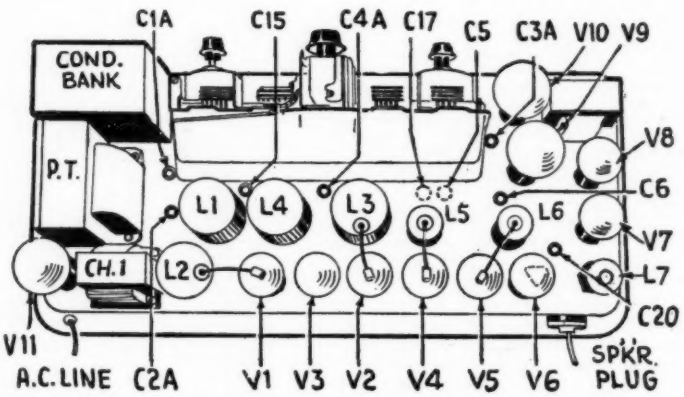
Condensers: C1, C2, C3, C4, tuning gang; and their H.F. trimmers, C1A, C2A, C3A, C4A. C5, C6, C17, C20 are I.F. trimmers; C6A, C7, C17A, C35, .00011-mf.; C8, C9, C10 (with resistor), C11 (with resistor), C18, C19, (and resistor), C23, .05-mf.; C13 and C16 (double unit), 0.25-mf.; C14, .0007-mf.; C15, L.F. trimmer; C12, L.F. resonator; C20A, .00005-mf.; C21, 0.5-mf.; C22, .00025-mf.; C24, .015-mf.; C25, C26, C28, C29, C30, C31, C32, C36 (in filter-condenser bank; see illustration of condenser connections); C27, tone control condenser bank; C33 and C34 (double unit), .015-mf.

Resistors: R1 (black), 10,000 ohms; R2, R3, R12, R13, R23 (silver gray, yellow tip), 100,000 ohms; R4, R5, R10 (with condensers), 250 ohms; R6 (orange), 50,000 ohms; R7 (brown body, black tip, red dot), 1,000 ohms; R8 (belgian blue), 13,000 ohms; R9, R14 (battleship gray), 500,000 ohms; R11, R18 (auto brown, yellow tip), 25,000 ohms; R15 (white), 250,000 ohms; R16, volume control; R17, R24 (jade green), 70,000 ohms; R19 (long tubular), 10,000 ohms; R20, R21 (one unit, flat, wire-wound, center-tapped), 35 ohms (each half); R22 (short, tubular), 800 ohms.

The operating voltages for the "Model 111" are as follows: Filament potentials: V1, V2, V3, V4, V5, V8, 2.1 volts; V6, V7, V9, V10, 2.2 volts; V11, 4.9 volts. Plate potentials: V1, V5, 190 volts; V2, 180 volts; V3, 45 volts; V4, 185 volts; V7, 35 volts; V8, 95 volts; V9, V10, 255 volts. Screen-grid potentials: V1, 60 volts; V2, 62 volts; V4, 65 volts; V5, 82 volts. Control-grid potentials: V1, 0.2-volt; V2, 4.6 volts; V3, 0.7-volt; V5, 2.2 volts; V6, V7, 0.4-volt; V8, 1.2 volts; V9, V10, 50 volts. Plate currents: V1, 1.7 ma.; V2, 0.5-ma. (as read on 20-ma. scale); V3, 1.6 ma.; V4, 1.5 ma.; V5, 3 ma.; V7, 0.2-ma. (as read on 2 ma. scale); V8, 4 ma.; V9, V10, 32.5 ma.; V11, 50 ma. per plate. Screen-grid current (as read on 2-ma. scale): V1, 1.75 ma.; V2, 0.15-ma.; V4, 1.7 ma.; V5, 1.85 ma.

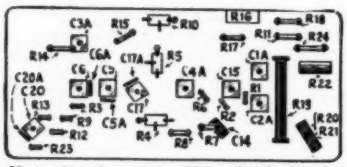


Condenser bank: note circuit change (dotted) in some models. Capacities are: C25, C26, C28, 0.5-mf.; C29, C30, 2 mf.; C31, 0.15-mf.; C32, .015-mf.; C36, 1 mf.; in 25-cycle model, C31, 0.3-mf; C29, C30, 3 mf.



Arrangements of parts on the top of the chassis of the Philco "111" Superheterodynes. Two trimmer condensers (C5, C17) seldom requiring attention are adjusted from the underside of the chassis. These two condensers connect, respectively, to the input and output windings of the first I.F. transformer, L5; and, in conjunction with this transformer, form a particularly selective input circuit for the first I.F. tube, V4. The oscillator adjustments are distinguished as "high-frequency" (C4A) and "low-frequency" (C15).

Note that these readings are taken with a line-potential of 115 volts, and volume control in the off position; with the station selector turned to the lowest frequency, and the range



Underside view of the Philco "111" chassis; showing only the fixed resistors and condensers, and the trimming condensers; their locations in the chassis may be fixed in relation to the long black resistor, R19.

switch SW 1 in the diagram set at "normal." Putting this switch in the "maximum" position increases greatly the sensitivity of the Philco "111" receiver. Positions "normal" and "maximum" are indicated in the diagram respectively as 1 and 2. Check the setting of this switch; since its incorrect use will result in the complaint of distorted reproduction and erratic operation, due to the overloading effect of powerful locals with the switch set at "maximum."

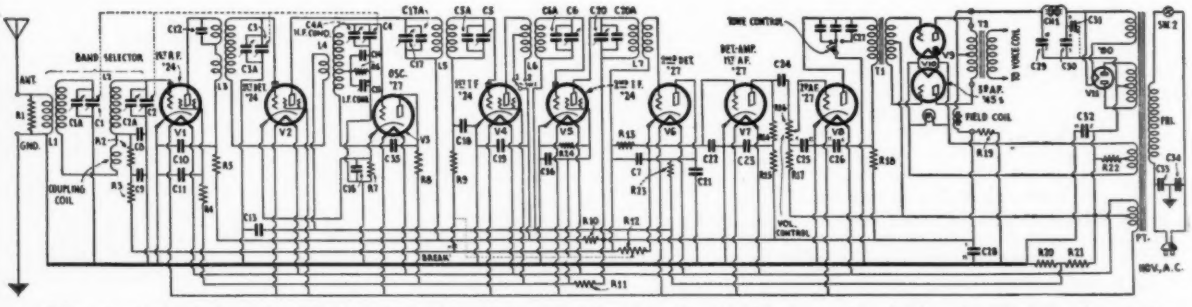
The factory makes the following observation concerning adjustment of the nine compensating or trimmer condensers: "These receivers are accurately adjusted at the factory prior to their shipment. Under no circumstances are the adjusting condensers to be changed in the field. This alignment requires special oscillator equipment, which all Philco distributors have. If for any reason the receiver needs adjustment, it must be returned to the distributor's service department."

"Model 111A" is a 25-cycle design, and its parts values vary slightly from the above. "Model 211" is a phonograph combination; while "211A" is its 25-cycle designation.

It will be noted, from the top-view illustration of the chassis, that two of the trimmer capacities are adjusted from the under side. Their locations, and the positions of all the resistors, are shown in the under view.

As indicated by dotted lines, those models dated later than March 15, 1931, are wired to place a higher bias on the first I.F. amplifier, V4. This connection is made by swinging the resistor R9 from the chassis to a center-tap which is obtained by changing R12 from a single 100,000-ohm unit to two 50,000-ohm units, and connecting them in series.

The intermediate frequency used in these models is 175 kilocycles. All final adjustments are to be made with switch Sw. 1 in its "normal" position, No. 1. A fiber wrench is required for adjusting the I.F. trimmers. The high-frequency circuits are to be adjusted at 1400 kc. The single "low-frequency" condenser C15 is to be adjusted at 600 kc. After adjusting the R.F. and I.F. stages, tune the receiver to the eighth harmonic of the I.F. circuits; the dial reading should then be 140. At this time, make any adjustment of the high-frequency condenser C4A which may be necessary.



Schematic circuit of the Philco "Model 111" Receiver. Tone control is obtained by shunting one to three fixed condensers across the output of the second A.F. tube, V8. Note that the center-tap of the high-voltage secondary does not connect directly to the chassis, but returns through two resistors, R20 and R21. The plate of V6 connects directly to the cathode.

CLARION "SERIES 90" SUPERHETERODYNES
(MODELS AC-90, AC-91, AC-91A, 25-90, AND 25-91)

The latest Clarion receiver, manufactured by the Transformer Corp. of America, Chicago, Ill., incorporates the newest advances in set design. Among the features with which the Service Man must familiarize himself are the following: a superheterodyne circuit with variable-mu tubes; a screen-grid first detector; a power screen-grid second detector; a pentode power stage; together with tone control, tuned hum filter, and automatic volume control; as the circuit illustrates.

Models "AC-90" and "AC-91" operate on 110 volts 60 cycles; and the "25-90" and "25-91," on 25 cycles. Model "90" is mantel-type; Model "91," a console, and Model "91-A," a phonograph combination.

The volume control, in its extreme left position, operates a phonograph switch, in the Model "90A" receiver; the phonograph pick-up circuit being shown dotted in the diagram; and the switch at X. The pick-up impedance should be between 2000 and 5000 ohms; and the volume controlled at the unit.

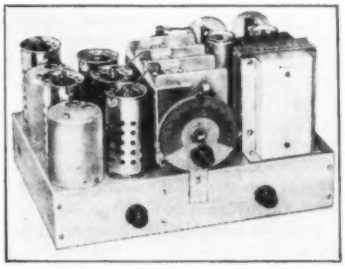
All available constants are as follows: condensers C1, C2, C3, tuning units; C1A, C2A, C3A, shunt trimmers; C5, C21, .0008-mf.; C6, C7, C8, C9, I.F. circuit trimmers; C10, C15, C16, C18, C20, C22, C23, .05-mf.; C11, 0.25-mf.; C12, 1.0-mf.; C14, C24, C27, C28, 0.1-mf.; C17, .00005-mf.; C19, 0.35-mf.; C25, C26, 8 mf. (electrolytic).

Resistors R1, R3, R6, 1,000 ohms; R2, 230 ohms; R4, 2,000 ohms; R5, R9, 100,000 ohms; R7, 40,000 ohms; R8, ½-meg.; R10, 1.0-meg.; R11, 12,000 ohms; R12, 3,800 ohms; R13, 4,300 ohms; R14, 1,800 ohms; R15, 1,300 ohms; R16, 435 ohms; R17, 400 ohms; R18, 65,000 ohms; R19, 20,000 ohms; R20, 210 ohms.

Operating voltages (with volume control in position "full" and line potential 115 volts) are as follows: Filaments V1, V2, V3, V4, V5, V6, V7, 2.2 volts; V8, 4.6 volts. Plate potentials, V1, 160 volts; V2, 168 volts; V3, 125 volts; V4, 163 volts; V5, 178 volts; V6, 25 volts; V7, 260 volts; V8, 350 volts. Control-grid potentials, V1, 0.9-volt; V2, 7.6 volts; V3, none; V4, 0.6-volt; V5, 6.8 volts; V6, 4.6 volts; V7, 16.5 volts. Cathode potentials, V1, V4, 2 volts; V2, 4.9 volts; V3, none; V5, 9 volts; V6, 4.5 volts. Plate currents (normal), V1, 2.8 ma.; V2, V4, 2. ma.; V3, 9.5 ma.; V5, 0.25-ma.; V6, none; V7, 36 ma.; V8, 72 ma. Screen-grid potentials, V1, V2, V4, 77 volts; V5, 90 volts; V6, 40 volts; V7, 260 volts.

Removal of the tube shields will cause circuit instability. Use of the variable-mu tube eliminates the hissing sound usually associated with high-gain superheterodynes. The manufacturer's (T.C.A.) code for the tubes is as follows: V1, V2, V4, CL-51; V3, CL-27; V5, V6, CL-24; V7, CL-PZ or CL-47; V8, CL-80.

The above readings on the pentode were taken



Chassis of Series "90" Clarion: compare this illustration with the coded layout at the lower right.

in the following manner: the plate potential is read between plate and filament prongs, on the 250-volt scale. The control-grid is checked between the black common lead (on the reproducer's voice coil) and ground. The space-charge-grid is tested between this prong and filament. Connections to the UY base of the 'PZ resemble those of a '27—except that the cathode prong becomes the space-charge-grid lead. An adapter which exposes these five connections will be of assistance to Service Men not yet provided with modern analyzers designed to test pentodes.

Lack of sensitivity may be due to an open circuit, a high resistance, or a short circuit; seldom to trimmers out of adjustment. Exceptional care is taken to align these circuits accurately; after which they will retain their adjustment in nearly all instances.

Poor selectivity is seldom due to mis-alignment of the tuned circuits; but, more often, to a high-resistance joint in an R.F. circuit. An ohmic test may not indicate the faulty connection; but the application of a soldering iron to suspected joints may clear the trouble.

To align the I.F. circuits, (if the procedure is imperative), use a bakelite screwdriver to adjust C6, C7, C8, C9 for maximum output meter reading; with a 175-kc. (exact) oscillator output wired to the cap of V2, all tubes in their respective sockets; and all cap leads connected.

The R.F. circuits are to be aligned at 1400 kc. and 600 kc.

The oscillator low-frequency "padding" trimmer C4 is next adjusted, with the R.F. oscillator (connected to the antenna and ground posts) operating at exactly 600 kc.; at the same time, the receiver's dial is to be swung back and forth over the 600-kc. setting—adjusting for maximum output. Repeat the operation at 1400 kc.; except that C3 (the high-frequency tuning condenser) remains fixed, only C3A being adjusted, if necessary. Check also C1A and C2A.

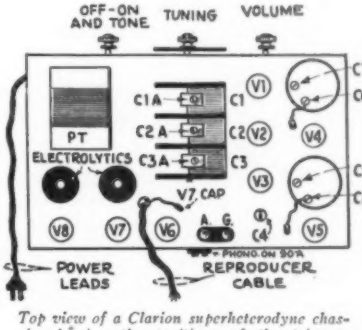
High-percentage modulation at the transmitter will result in increased signal strength at the receiver, as compared to other stations for which the automatic volume control has been adjusted.

Poor tone quality may be due to off-resonance tuning by the listener. Check by using a short-wire antenna, with volume control full on; the automatic volume control circuit will then cease to level the signal strength, and a tuning peak can be obtained. A poor '24 second-detector may mar the tonal reproduction; check also V6. A "fluttering" signal may be due to a poor ground.

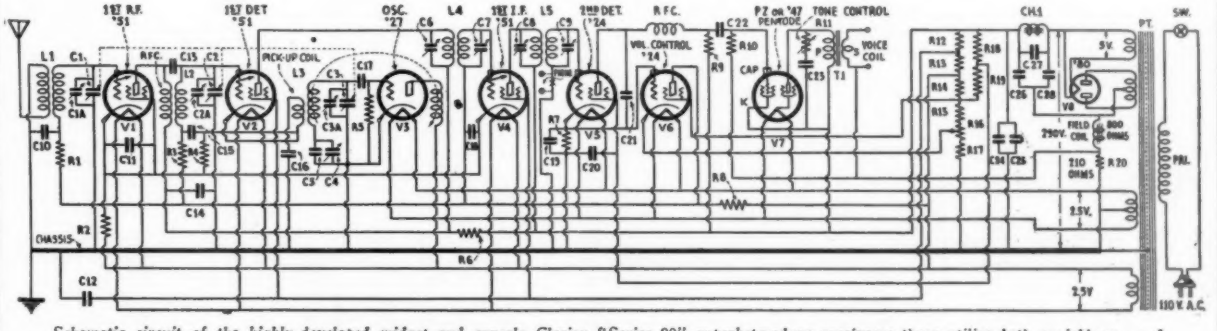
A 100-watt lamp should light brilliantly when connected between ground and one side of the light-line. A dim light indicates a poor ground connection; and no light, an ungrounded light-line. If the power company corrects the latter condition, hum, fluttering, circuit oscillation, and back-ground noise may be eliminated.

Although the intermediate frequency of 175 kc. has been selected by most manufacturers as the most satisfactory it is to be noted that a weak fourth harmonic, 700 kc., may heterodyne a broadcast station carrier and cause a whistle. Another cause of circuit oscillation is high line voltage; look also for open by-pass condensers.

Note that one side of the filament secondary which supplies V1, V2 and V4 connects also to other parts of the circuit, including the cathodes of V1 and V4, and the plate of the oscillator V3; and that, with respect to ground, this lead has a positive voltage of 95.



Top view of a Clarion superheterodyne chassis showing the positions of the trimmer condensers. The phonograph connection appears only on the "Model 90-A" chassis.



Schematic circuit of the highly-developed midget and console Clarion "Series 90" superheterodyne receivers; these utilize both variable-mu and pentode tubes, with automatic volume control. (Note: in the manufacturer's "breakdown analysis" illustration of this receiver, condensers C24 and C25 return to the juncture of R10 and R20, instead of to the chassis.)

Operating Notes for Service Men

Some Tips on Supers of More or Less Recent Vintage

By BERTRAM M. FREED

SINCE the trend of the radio design has returned to the formerly-popular superheterodyne, perhaps some notes concerning a few of the models which have lately made their appearance on the market will be of interest.

In the Silver-Marshall super, a compact job (which is being sold under several names), the speaker cable of six wires terminates in a five-prong plug, which is inserted into a receptacle provided at the rear of the chassis. One wire (the black) is not connected to the plug, but must be grounded to the chassis before any reception is obtained. (See Data Sheet No. 34, January, 1931, RADIO-CRAFT.)

If the fine wire of the volume-control resistor strip breaks, intermittent reception is caused; the remedy is replacement. The value of this resistance is 3,000 ohms.

Care should be exercised in selecting '27 tubes for the new Atwater Kent pentode model; or difficulty may be encountered.

After a great deal of bother and fuss over hum in a new "Model 20" Majestic, using variable mu ("Multi-Mu") tubes, the cause was found in an open by-pass across the 35,000-ohm resistor which biases the second detector. The unit contains a pair of 0.4-mf. capacities.

One of the most perplexing jobs yet encountered by the writer was a Radiola "60"; for a long time, volume had been decreasing. Naturally, the tubes were first suspected; those in the set were not too good, but their replacement did not greatly improve reception. The next move was to take down the condenser gang, in order to check and realign the I.F. transformer adjustments. These are tuned to 180 kc.; trimmers and compensators were then adjusted for maximum efficiency.

However, all this work counted for little; only three of the powerful broadcasters were picked up with any degree of volume. With the aid of a schematic circuit, all voltages, resistances, and capacities were carefully checked. The plate voltages of all amplifiers were found about 40 volts lower than specifications. The condensers were not at fault; so either a partially-grounded coil or a bad resistor was indicated. Finally, under the pack, a heavy black carbon resistor (see Fig. 1) was found which should have been, according to the diagram, 20,000 ohms; it tested 14,000. It was removed and replaced by a 25,000-ohm component, the handiest value obtainable. Immediately the voltages became slightly above normal, and the set perked as it had never done before. This resistor is a bleeder, connected across the 135-volt supply tap to prevent any excessive rise in voltage; such as would occur

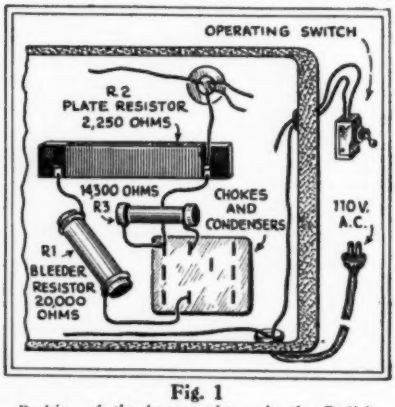


Fig. 1

Position of the large resistors in the Radiola "60" power pack.

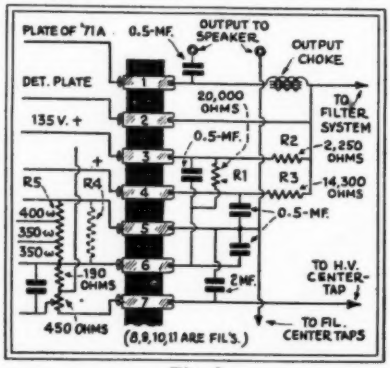


Fig. 2

The terminal strip of the Radiola "60"; for distance reception, sensitivity may be increased by introducing R4, especially as a variable panel control.

if all the tubes were removed, and which might cause punctured filter condensers. In some instances, a lack of a few thousand ohms in this resistor has caused trouble.

Improving Sensitivity

While the Radiola "60" is highly sensitive and selective when in best operating condition, the writer has been approached more than once with a request to "do something to it," to pick up the stations which come in very weakly. After checking up the set, as described above, the next step was to try additional by-passes in different parts of the set. This did not help; it then seemed advisable to increase the plate voltage; and this was done by replacing the large wire-wound resistor under the pack with one of lower value (about 500 ohms) but without effecting any improvement. Then resistors of different values were shunted across the four sections of the wire-wound unit which is secured to the front wall of the receiver, next the volume control. The tuning dial had been set nearly at 30 and, when a 700-ohm resistor was shunted across the 400-ohm section (next the volume control) Omaha came crashing in with a wallop. When this shunt was removed, reception ceased.

After experiments with different values, centering around the biasing resistors, it was noted that a resistor of 400 to 700 ohms worked best when shunted across the 400-ohm unit; but that the volume control had then no effect when a powerful station

(*Continued on page 45*)

Making Money in Radio Servicing

Ideas for the Application of a Little Salesmanship

By W. E. SMITH

NEVER before have there been such great opportunities to make money by servicing radio as there are today. The finest and best radio receiver, sold only a month ago, may be now obsolete; since there have just come upon the market several new tubes which are a vast improvement and, of course, these tubes will better any radio.

The Service Man's business is, to give the community which he serves the best there is in radio. By this I do not mean selling gadgets, but incorporating improvements into your customer's radio.

Many Service Men, as well as the general public, regard the radiotrician's profession as merely a job of fixing receivers. I regard my work as giving my customer the best in radio reception and, of course at a profit. And I find the customer ready and willing to pay for real service.

Only this year, a great many supers have been sold that can be improved by the use of the type '35 variable "mu" tube. It will be necessary, if the set in which these tubes are to be installed has variable screen bias, to fix this at 75 volts (with a fixed resistor), and use a variable resistor for the cathode bias. The value of the latter depends on the number of tubes it is to serve. **(Fig. 1.)**

You will be surprised at the sales opportunities you will find if you take along with you, on service trips, a short-wave converter of the superheterodyne type. Most people are now "off" the plug-in adapters; the ideal short-wave converter installation is permanently connected up, so that either

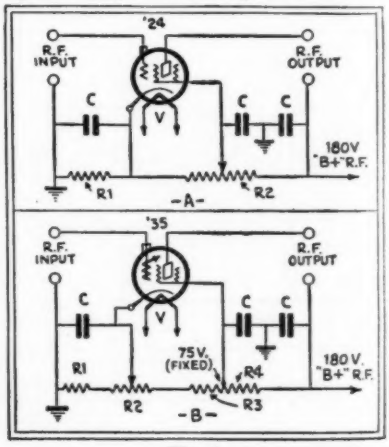


Fig. 1

To convert a standard screen-grid set for variable-mu tubes, the circuit is altered from A to B. Values depend on the set.

short or long waves can be selected by throwing a D.P. D.T. switch.

One of the ideas I have been able to cash in on is altering receivers so that the short-wave police calls can be picked up. This can be done on any receiver, merely by taking off turns of each tuned secondary. Sometimes it is possible to realign the trimmers and get frequencies high enough. I would not advise changing single-dial supers, unless you are thoroughly versed in this type of receiver.

Then there are the new pentode power tubes, which can be installed in any set, whether A.C. or D.C. There are several

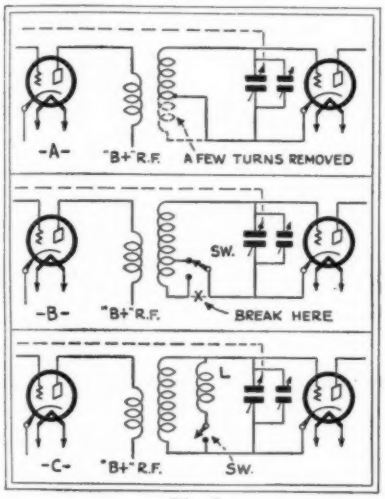


Fig. 2

To receive police calls, below 200 meters, it is necessary to reduce the minimum inductance of the tuning coils. Some methods are shown.

types for different filament voltages; consult the table of characteristics.

A great many sets have the leak-condenser detector; here a power detector may be installed, with consequent increase in both selectivity and tone quality.

In a district supplied with 110 volts, D.C., you will find any amount of battery-operated sets that can be changed to work off the house lines. Incidentally, there is on the market a new series of tubes which are ideal for this job, viz.: the '36, '37, and '38. All these tubes operate on the same filament voltage (6.3) and filament current (0.3-ampere). Bias can be obtained in the same way as in A.C. tubes, by the voltage drop across a resistor between cathode and ground. (See page 731 of June RADIO-CRAFT for characteristics.)

There are a great many automobile receivers that can be improved by the use of these tubes.

Very recently there came on the market a midget receiver using three '24's, one '45 and one '80 type tube. I purchased a lot of four of these receivers for $70 and changed them to use two '35's, one '24, one '47 and one '80; which increased the range and volume most noticeably. The expense for two resistors, one output transformer and 4-mf. condenser came to about $6.00 per set all told. However, I happened to have these items on hand, salvaged from junk sets; and I sold these receivers for $69.50 apiece.

(*Continued on page* 48)

Service Men's Notebooks

A few leaves from the experiences of our readers. What have you found in your daily rounds?

DEMONSTRATING THE IMPROVEMENT

By George H. Gable

SOME months ago, the same idea which Mr. Freed describes (on page 651 of May issue of RADIO-CRAFT) occurred to me; that of improving the Majestic "Seventy" series, by replacing the push-pull '71A's with '45's. The latter, with their filaments wired in series, give a better output.

However, customers usually want to hear for themselves before they authorize the change. How is that possible?

Very simple, if the adapter sketched in Fig. 1 is used. The parts required are two tube sockets, two 4-prong plugs and cords, small clips, a suitable variable resistor R and center-tapped filament resistor R1. As the diagram shows, the grid and plate connections of the adapter are wired to their respective prongs on the two plugs, while the filament current is drawn from one socket of the set. The battery is used for additional grid bias, using the variable resistor to obtain the correct value.

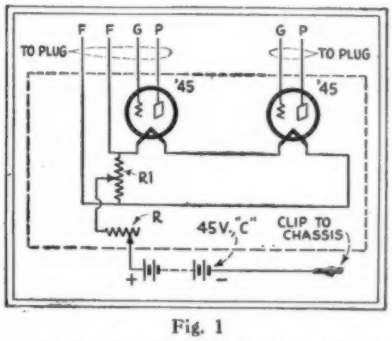


Fig. 1

The customer wants a sample of the proposed work? Very well; this will give it to him.

A HINT OR TWO ON PHILCOS

By James W. Roberts

SERVICE Men have, no doubt, had trouble in locating the cause of very weak reception of all but strong local stations on Philco "Neutrodyne-Plus" sets where, upon checking the set with a set of analyzer, all voltages with the exception of the grid bias voltage on the first R.F. tube were O.K. The first R.F. tube showing no grid bias, and the second and third R.F. showing grid bias (whereas all tubes get their bias through the same source), tells us that there is an open in the secondary of the first R.F. circuit. A continuity test of the secondary shows it closed; this leaves only the range control, which is a small variable compensator across the first tuning condenser and functions as a "local-distance" switch when turned all the way to the left. Examine the range-control spring for an open from the stator to the spring. If the spring does not make contact to the stator, when not in "local" position, no grid bias is applied to the first R.F. tube; and the set will not bring in anything but strong locals. In most cases tension can be restored to the spring by bending with a pair of duckbill pliers, or install a new range control (Philco Part No. 3133).

When cases of oscillation in the Philco N-P sets cannot be cured by neutralizing, the trouble is usually caused by an open R.F. plate condenser in the plate resistor-condenser cartridge. The easiest way to test this is to remove the grounding screws and lift the cartridges so the condenser of the unit is not grounded and test the condenser with an A.C. voltmeter in series with the light-line. Open condenser will show up by not giving a reading. If a Philco part is not available, an .05-mf. condenser can be shunted from ground to the resistor-condenser terminal. Reground all resistor-condenser cartridges, replace bottom pan and re-neutralize the set; and you will find the oscillation is cured.

Upon investigating some complaints of noise in Philco "Models 95-96-76-111-77," where the volume was fairly loud, it was found that the primary of the R.F. transformers was the cause of the trouble. The primary is a small coil inserted inside the bakelite tubing at the bottom of the transformer (meaning the end away from the bracket) and is wound with very fine wire. In nearly all cases, it has been found that this fine wire has been broken and only lies against the terminal. When the volume is turned up, the vibration of the speaker causes this wire to make and break contact; resulting in a very disagreeable noise at the speaker. In cases where the wire has broken at the outside terminal of the primary

(*Continued on page* 44)

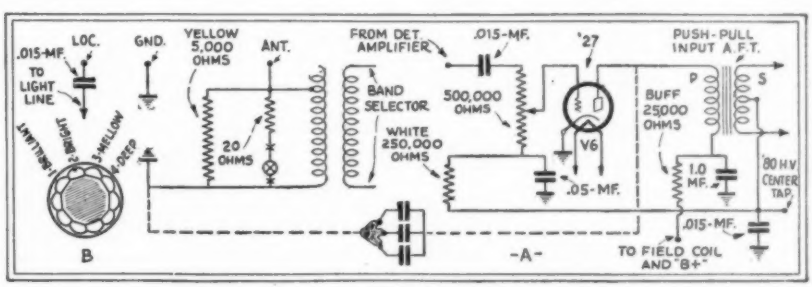


Fig. 2

The Philco tone control may be introduced into an earlier model conveniently, wherever the "local-" distance" switch may be dispensed with to provide a place for panel mounting.

The Service Man's Open Forum

A Place for Free Discussion of Trade Problems

MR. RABE BREAKS HIS RULE

Editor, RADIO-CRAFT:

Every so often I read something in your publications which is so disgusting that I should write you about; especially letters from Service Men which must be correspondence school beginners.

Take for example the Colonial Midget, the article states that set and speaker must both be removed at once. On this set there is a small arrow on the dial and when this is up to the station pointer a cutout on the dial will slide out under the speaker. Another writer wrote about neutralizing an RCA 44.

Why don't you get in contact with some first-class Service Men and have the letters checked over before printing them? On the other hand, first-class Service Men are loath to put out information for the benefit of competitors. I know, I do not put out any.

H. HOWARD RABE,
620 *North Park, Fremont, Nebraska.*

(Mr. Rabe is correct in his observations concerning the midget's dial, as an examination shows. It is also obvious that the writer of the article concerning the "44" put down "neutralizing" hastily for "aligning"; it is well known that small condensers are often called "neutralizing," though used for other purposes.

While the service notes in RADIO-CRAFT are checked over, it is true that errors must occasionally slip through; and we are glad to have our readers point them out for correction. Then, too, we are glad to observe the increasing willingness of manufacturers and Service Men to give out information by which not only their competitors, but the whole trade, may profit. "I've noticed," said David Harum, "that it ain't a bad idea to let the other fellow make a dollar once 'n a while."—*Editor.*)

TO OTHER I. S. M.

Editor, RADIO-CRAFT:

Regarding the letter of Mr. D. C. Karr, in which a broadside is delivered at General Motors radio: first of all, RADIO-CRAFT has gone to a lot of expense and a tremendous amount of corresponding, checking, etc., to put in the hands of anyone desiring them, practically every diagram to be had.

Certain manufacturers, too, have their own ideas about this; and I am afraid it is too late for them to fall in line. Their sets have been dismantled, checked, values recorded, diagrams made, and all the rest of it; so why worry? Instead, let us boost those manufacturers who came right out and submitted everything they could to help radio along.

What experience have other readers had with the manufacturers? Some time ago I saw in RADIO-CRAFT a lot of letters, pro and con, regarding this question. Well, here I go:

Right on top, and where no one can deny they belong, is Silver-Marshall. My experience has been that they will send you anything and everything to help you, and they will be doing business when these other firms who are too "confidential" are bygones. Then come Philco, Hammarlund, Atwater Kent, Aerovox Wireless Corp., Tobe Deutschmann, and a lot more of the old-timers. Forget the "confidential" firms, and let us boost the "good fellows" instead.

Let us use good standard products, and stick behind the firms who will give us desired information. Cut out all this "gyp" stuff, and especially "gyp" tubes: let us find the demon who started "gyp" tubes and put him inside his product with about 180 volts on the plate—that is where he belongs.

And don't forget, fellows, that it was you and I who sent in our subscriptions, even before RADIO-CRAFT was published, and got behind Mr. Gernsback because we were convinced he was right. Let us stay behind him.

Some day, Mr. Editor, when space is not at a premium, might I suggest that you print a "Red" and a "Black" column, listing in their respective places the "good fellows" and the "confidentials"?

EDWIN T. PHILLIPS,
15106 *Chapel Avenue, Detroit, Mich.*

WHEN TO BUY A NEW SET

Editor, RADIO-CRAFT:

I find your magazine very helpful to the Service Man and my copy each month is read eagerly from cover to cover. This is my first letter to you, and in it I would like to record some of my observations and comments gleaned from several years of experience in this field.

To begin with I think there is not enough cooperation between the three divisions—selling, servicing, and manufacturing; in fact at times it seems as if they are working directly against each other. As I see it the manufacturer is primarily interested in

(*Continued on page* 48)

A Reference List of the Schematic Circuits of Commercial RADIO APPARATUS

Published in* RADIO-CRAFT *since the July,* 1930, *issue.

(Previous reference lists appeared in the April and August, 1930 issues of the magazine. All back numbers of RADIO-CRAFT are still available at 25 cents each, postpaid.)

August, 1930

Bosch "Cruiser," "Royal Cruiser," and "Imperial Cruiser" Model 35, Battery Sets (No. 23 Data Sheet), p. 78;
All-American Mohawk "One-Dial" Receivers, "Battery" and "A.C. 226-227" (No. 24 Data Sheet), p. 79;
Pilot Automotive Radio, p. 91;
Dubilier "Model PL 1985 S-G Duratran" Aperiodic R.F. Amplifier, p. 93;
Delco Automotive Radio (General Motors) p. 106;
"Radiola VII-B" Receiver, p. 104;
Samson "Double-Rotor" Circuit, "Model TC," p. 121;
Screen-Grid, 4-tube "3-Circuit Tuner," p. 122.

(*Continued on page* 60)

Every Milliammeter a Direct-Reading Ohmmeter

By FRANCIS R. EHLE*

ANYONE who works with radio circuits is, sooner or later, interested in a direct-reading ohmmeter for the purpose of measuring unknown resistance values and also testing the continuity of circuits. If the price is available, a suitable instrument can be purchased for this purpose. However, the experimenter or Service Man can readily convert the usual 0-1 milliammeter into a combination milliammeter and direct-reading ohmmeter, making use of the scale herewith reproduced.

To bring about the desired conversion of the milliammeter, the first step is to remove the meter from its case by loosening the three mounting screws. Remove the two screws holding the milliammeter scale in position. Place ohmmeter scale on top of old scale, fastening with a few spots of glue if desired, and replace the scale mounting screws. Connect meter, battery and calibrating resistance in series. The meter should now read zero on ohmmeter scale; if not adjust pointer with zero set screw. Replace meter in case.

The battery voltage and calibrating resistor determine the meter reading and, therefore, the accuracy of the ohmmeter. When a 1.5-volt battery or single dry cell is employed, in combination with a 1,500-ohm calibrating resistor, the scale is direct reading. If a 4-5-volt battery made up of three dry cells is employed, in combination with a 4,500-ohm calibrating resistor, the scale reading must be multiplied by three. With 22.5 volts as provided by the usual fresh "B" battery, together with a 22,500-ohm resistance, the scale reading is multiplied by fifteen.

By employing a 22½-volt tapped "B" battery, providing a choice of 1½, 4½ and 22½ volts, together with three resistors of 1,500, 4,500 and 22,500 ohms, the ohmmeter may be employed to cover any resistance readings from 0 to 750,000 ohms. Meanwhile, the former milliammeter function of the meter is by no means impaired, since a double-reading scale is now available.

The direct-reading ohmmeter described presupposes the use of precision wire-wound resistors of an accuracy within 1% of their rated resistance value; ordinary resistors will not do. Our recent development of precision wire-wound resistors (incorporating such unique features as a special ceramic form with successive sections to hold the winding; the highest grade of enamelled resistance wire; special impregnating compound which hardens with high temperatures instead of softening; the moulded end contacts; and the unique method of balancing the winding to the exact resistance value) now makes the usual milliammeter and voltmeter available for a greater variety of uses, without sacrificing

(*Continued on page* 51)

* *President, International Resistance Co.*

Replacement Resistors

By HARRY GEORGES

OBVIOUSLY, it is impossible to judge the quality, accuracy of rating, or duration of useful service of any radio component by a mere visual inspection; this statement applies with especial weight to fixed resistors. They all seem to look very much alike and some are still sold very cheaply and are announced as wonderful "bargains."

The intelligent radio Service Man, however, realizes the need of careful selection and discrimination in the use of replacement parts. He has learned, often through sad experience, that *resistor bargains simply do not exist.*

The cheap replacement is the cause of many kinds of radio troubles. In nine cases out of ten, the low-quality resistor is inaccurately rated, sometimes even to the extent of being half or double the marked value. In many cases, such discrepancies are noticed by the Service Man as soon as he solders the replacement resistor into the set. Where the resistors determine plate, grid, or screen-grid voltages, these potentials may be so far removed from normal, that it is impossible for the tubes to function.

Sometimes, however, the resistance, although incorrect, is not far enough "off" to prevent the tube from operating. Still, the operation is of poor quality, due to the use of the wrong resistance value; and so, while correcting one fault, the Service Man may introduce another, merely through the use of a "bargain" resistor.

Another possibility is, of course, that the resistor of incorrect rating may be of a value which will permit the tube to operate with apparent efficiency, yet overload the tube, causing a serious shortening of its life. Even in the single case out of a hundred, where the cheap resistor happens to have an ohmage approximately the same as its rated value, it is certain to deteriorate rapidly and cause noticeably poor or at least inefficient operation, resulting in tube burn-outs or other similar troubles. The poor-quality resistor may only burn out itself; this is about the best thing that it could do, for it thus calls attention to the desirability of using a good resistor. Unfortunately, most of the other troubles mentioned above, occur *before* the resistor goes "haywire."

In order to obtain a more definite idea of just what an improperly rated resistor can do to the operating characteristics of a tube, actual data will be given, to show exactly what happens in the case of a screen-grid tube of the '24-type.

Incorrect Screen Potentials

Suppose, that there is a 190-volt tap on the voltage divider, and that the current is supplied to the screen grid from this tap; the voltage being reduced to the normal operating voltage of 90 by means of the drop across a 100,000-ohm fixed resistor, R, Fig. 1. In other words, with a current of 1 mil. (.001-amp.) flowing, there is a drop of 100 volts.

Now, consider the case where a replacement resistor marked 100,000-ohms is used, but assume that this resistor has an actual resistance of 140,000 ohms. In such a case, the voltage drop will be 140 volts and, hence, the voltage at the screen grid will be 50 volts instead of 90 volts.

An examination of the accompanying chart, Fig. 2, showing dynamic characteristics of the "Type 124" Arcturus tubes, indicates that with 90 volts on the screen-grid, the tube has a mutual conductance Gm of 1050 (other values such as plate voltage, etc., being normal). The amplification factor is 400, and the plate resistance Rp is approximately 400,000 ohms.

At a screen-grid voltage of 50, however, the mutual conductance drops to 675, the "mu" is 800, and the plate resistance increases to 1,200,000 ohms.

Without considering mathematical equations, we can see at once that, since the mutual conductance (Gm) is an indication of

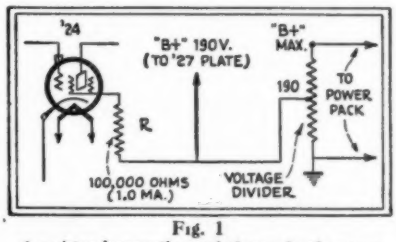


Fig. 1

A resistor incorrectly marked may be the cause of numerous faults in a radio set. An instance is illustrated above, at R; too high a resistance destroys sensitivity.

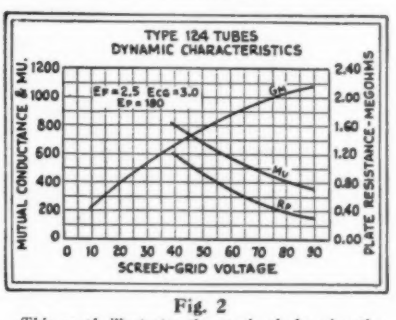


Fig. 2

This graph illustrates the result of changing the screen voltage of a screen-grid tube.

the efficiency of the tube, it is evident that this has been very greatly impaired. It is always desirable to have the mutual conductance as large as possible; but here we see it reduced 40% by reason of the use of an improperly-rated resistor.

We may apply a simple engineering rule to determine the effect on sensitivity. The gain of a tube is, when it is used in an amplifying stage, not its theoretical amplification factor, or "mu," but the "mu" multiplied by the effective impedance (Z) in its plate circuit, and divided by the sum of its plate resistance (Rp) and the effective impedance load; since the latter two constitute the series load across which voltage is divided. That is:

$$\text{Gain equals } \frac{Mu \times Z}{Rp + Z}$$

(*Continued on page* 46)

DETROIT PUBLIC LIBRARY

Hints for Radio Manufacturers

By SERVICE MEN

Two-Volt Storage Battery

NOW that we have a good line of 2-volt tubes, would it not be a paying proposition for some concern to put out a single-cell of high amperage that could be recharged like those already on the market? Such a battery would be much smaller than the air-cell type, and there would be less danger of overloading the tube. The writer has had this suggestion poked at him so often, by those who cannot see anything in the big air-cell battery, that he passes it on for what it is worth.

A. W. McVEY,
821 *Locust St., Philadelphia, Pa.*

(The two-volt "accumulator" has been in vogue abroad for years, since tubes suited to operation in this manner were available. However, the two-volt storage battery will require periodical charging, even with a set of small consumption; and therefore the air-cell battery serves a distinct purpose for which it has no competition except the dry-cell.—*Editor*).

A Little More Metal

MANUFACTURERS might well use a little more iron and copper when constructing filament and plate-supply transformers. After some sets have been operated four or five hours, if the transformer is accidentally touched, one feels like rushing to the street and shouting "Fire!" Or do they believe in giving extra value by providing an electric heater in combination with the radio?

H. A. DEAL,
69 *Glenwood Glade, Oakland, Calif.*

Less Cross-Talk

DEALERS and Service Men, right now, should have equipment to handle the large recording discs—talking-picture 16-inch size; the public is not, as was suggested in this column some time ago, quite ready for them. How many pickups and consoles could take care of them? I have at different times recorded radio programs on 12-inch discs, and had a recording time of 11 to 12 minutes; using an electric motor with a power Clarostat to control voltage and thereby speed (though some high-priced motors have a speed regulator.) A Service Man, free to travel, could make a nice profit, as it is estimated that 45% of picture houses are not yet wired for sound—10,231 out of 22,731.

But what I have to say, last but not least, is: give the public selectivity in a cheap receiver.

WILMAR A. SHIFFLET,
149 *Miller Ave., New Castle, Pa.*

Put Back the Jacks

PUTTING a phone jack somewhere in the set, for the use of headphones. This would give extra enjoyment to a lot of

(*Continued on page* 49)

The New Scott "All-Wave" Superheterodyne

An all-purpose, high-quality receiver for the distance fan who is exacting in his demands.

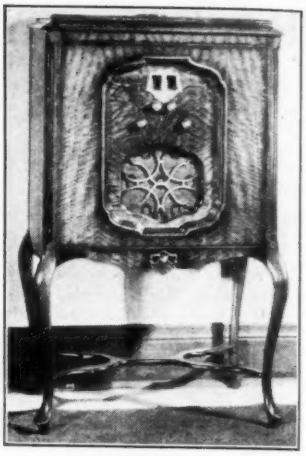


Fig. A
Panel appearance of the All-Wave Superheterodyne in a suitable console.

THIS handsome radio receiver, completely-shielded (even to a base cover-plate), and designed to cover wavelength ranges of 15 to 184 meters, and 200 to 550 meters, is the latest of the distinguished series of distance-getting receivers developed by the Scott Transformer Company of Chicago. The schematic circuit of the receiver chassis is shown in Fig. 1; and that of its power pack in Fig. 2.

Experimenters have long wanted a receiver which would get that "*n*th degree" of efficiency obtained by using inductance values requiring the least tuning capacity, for a given frequency adjustment. The Scott All-Wave Superheterodyne receiver obtains this result by the use of six sets, each of two top-engraved plug-in coils. One set of inductances, which we will call A, covers a band of 15 to 21 meters; set B, 21-27; set C, 27-38; set D, 38-84; set E, 84-184; set F, 200-550.

Accessories for Versatile Performance

As we have pointed out in the articles on sound recording in past issues of RADIO-CRAFT, a high-power audio amplifier must be used for best results. The Scott superheterodyne is peculiarly adapted to this work; since it makes provision for the connection of a microphone output, or a phonograph pick-up, to the input circuit of the second detector, as shown in the schematic circuit. This makes available, therefore, for home recording, a first stage of A.F. amplification using a type '27 tube; a second using two of these tubes in push-pull; and a final stage, also push-pull, using type '45 tubes. The combination is particularly desirable to give an audio output, as in this receiver, of high quality.

To enable the owner of an "All-Wave" to obtain the best results in the use of microphone, phonograph pick-up, and recording head, there is available an accessory unit, a Control Box, Fig. D; and, also, to match its constants, a hand microphone and a 200-ohm phonograph pick-up.

Details of the Circuit

As indicated in Fig. 1, there are nine tubes in the receiver chassis; and in the power pack, two more audio tubes, type '45, with an '80 rectifier. Five of the tubes in the receiver chassis are of screen-grid type ('24s) and the remaining four are '27s. The R.F. or signal-frequency amplifier V1 is a '24; the first detector V2 is another; the following three '24's, V4, V5, V6, are I.F. amplifiers; and the last, V7, is the second detector.

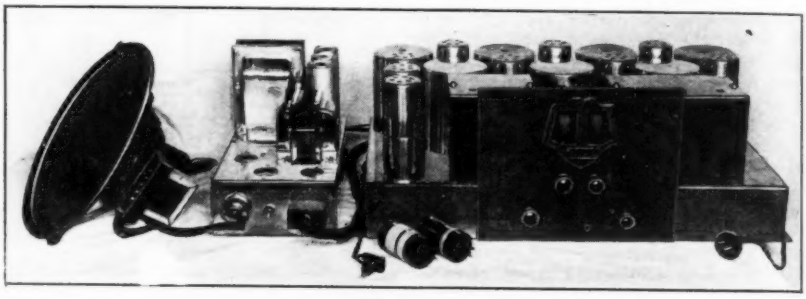


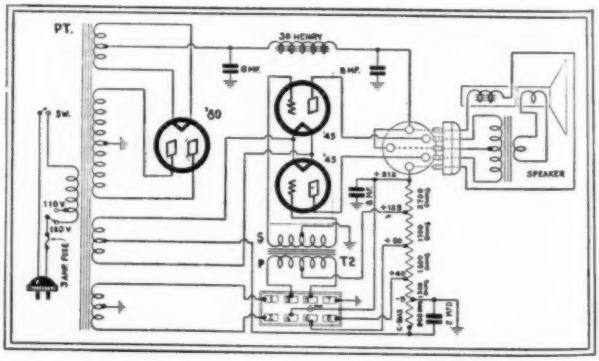
Fig. B
From right to left, tuner, amplifier-pack, and reproducer; showing the connecting cables which give flexibility of placement. Note the complete shielding nad strong construction.

The manner in which such circuits are compensated at the extremes of tuning range (by the selection of .0005- or .00007-mf. tuning capacities, respectively) has been discussed in past issues of RADIO-CRAFT; and nothing further will be stated on this subject; except to remark that a sixth (center) pin on the oscillator inductance operates the switch Sw. Further, the control-grids of V1 and V2 are connected either through red leads for the red-dotted coil sets A, B and C, or through black leads for coil sets D, E. F.

The shield cans are to be used only over the coils used on the broadcast range—200-550 meters. It is necessary, in order to reach the highest-frequency tuning range, to use a '27 tube with a continuous-sheet (not wire-mesh) plate at V3.

As will be observed by reference to Fig. A, a low-boy console is recommended for the Scott All-Wave Superheterodyne chassis

Fig. 2 (right)
The circuit of the power pack, with its connections to set and speaker.



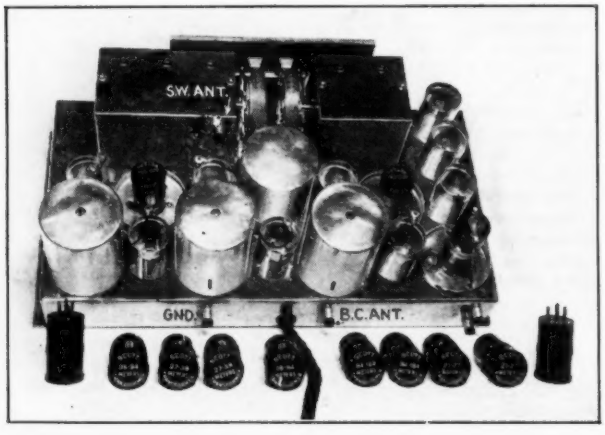


Fig. C (left)
A rear view of the tuner chassis, with all coils. It is unnecessary to shield the short-wave coils, which are therefore easily exchanged.

and its power pack. The lid of this cabinet must be readily lifted for convenient exchange of coils, etc.

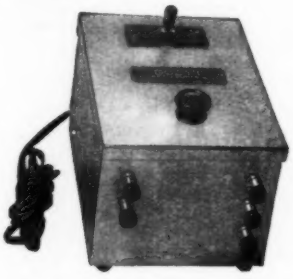


Fig. D

The microphone control box is obtainable as an accessory for recording or speech amplification.

Knack of Short-Wave Tuning

The short-wave enthusiast who has been accustomed to handling other types of short-wave receivers will be pleasantly surprised by the ease of tuning at all points throughout the range of this receiver; this is due, in great part, to the subdivision of the inductances.

A factor in the consummate ease of operation at the shortest wavelengths, right down to 15 meters, is the design of the input circuit of V1. When the first five coils are in use, the antenna connects to the binding post S.W.

Excellent selectivity is obtainable, even at the full sensitivity of the receiver, which is obtained with switch Sw. 2 in position 3.

Just a little fatherly advice concerning the procedure in tuning for the short-wave signals. It will be found that, although the tuning is very simple after a little practice, the listener may observe a tendency for stations to "whip" across the settings; this is due almost entirely to a natural tendency to tune the set as though it was one of the earlier two-dial tuned-radio-frequency receivers; a mistake in the handling of a short-wave superheterodyne. The only really satisfactory method of tuning is to set the left or oscillator dial at a given point, and swing the right or signal-frequency dial back and forth, slowly, a few degrees on either side of the I.F. resonance position (which is that point where a "resonance rush" is heard); then advance the oscillator dial's setting a fraction of a degree and repeat the operation with the right-hand dial.

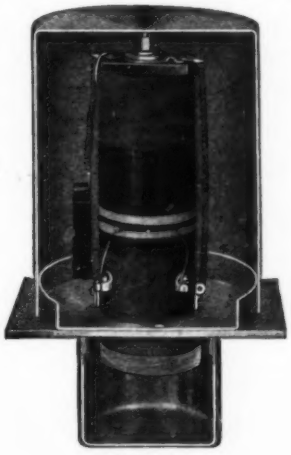


Fig. E

Cross-section of an I.F. transformer; observe "sub-panel" position of shielded R.F. choke.

After operating a Scott All-Wave Superheterodyne at a selected locality in Brooklyn, N. Y., the writer wishes to urge that due care be given to the use of the volume control; which is the potentiometer R in the diagram. There is a natural inclination to advance the setting too far, thus greatly overloading the tubes; since the amplification obtainable through the correct use of the screen-grid tubes is simply tremendous. (Speaking in technical terms, this receiver has at 1,400 kc. a sensitivity of one-one hundredth of a microvolt per meter!) However, if the volume is held at the correct level, there will be no hissing sound and no hum, but perfect audio reproduction.

Taken in its entirety, the Scott All-Wave Superheterodyne, with its tuning range of 15 to 184 meters, and 200 to 550 meters, should appeal to anyone interested in obtaining an exceptionally sensitive radio receiver, operable within these wavelength limits, and designed particularly for ease in tuning and high-quality audio output.

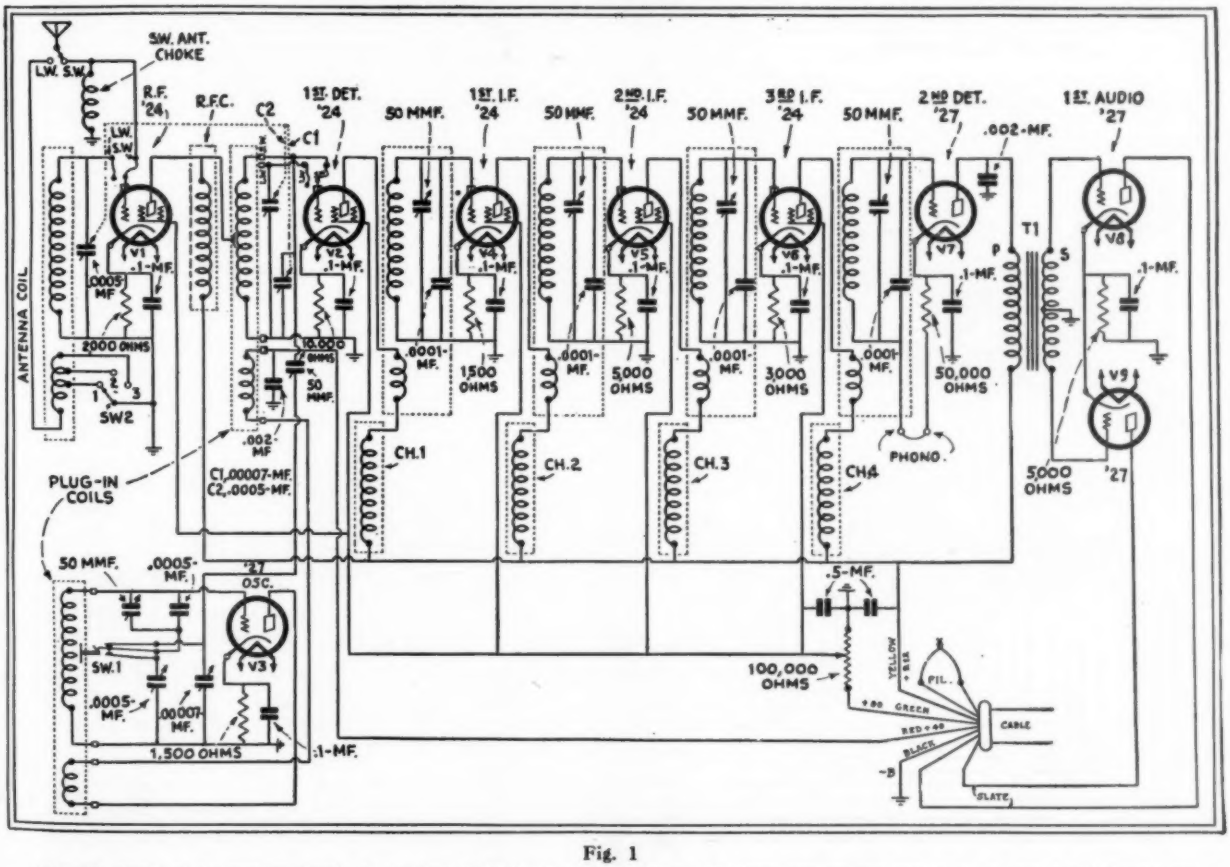


Fig. 1

Schematic circuit of the receiver chassis of the Scott "All-Wave" superheterodyne. The long-wave antenna post is at the rear of the chassis; and the short-wave post on the shield over the tuning gang. The output feeds a push-pull '45 pack (Fig. 2); a push-pull '50 unit is also obtainable.

And Now the Crosley "Super Buddy Boy"

In which the "Midget" set develops a giant's reach and voice

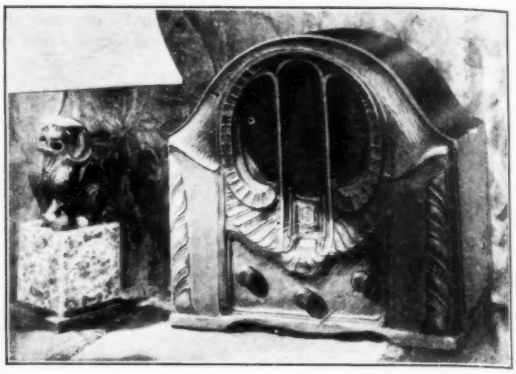


Fig. A
"Super Buddy Boy" is little, but oh my—!

WE tried out this superheterodyne in New York City, and were struck by the remarkable amount of power that such a small set can develop. It is literally impossible to turn the power on full; as the volume is entirely too great for locals.

Even on the distant stations, such as Boston, Pittsburgh and Chicago, the volume was often uncomfortable when the set was turned on full power.

It was found possible, in the heart of New York City, to tune in stations within a radius of a thousand miles without interference from the locals; which we think remarkable.

This receiver worked exceedingly well without an aerial; it was necessary only to connect the ground lead to the aerial binding post, and this worked exceedingly well even on distant stations.

SCORE another bulls-eye for the Crosley Radio Corp., whose engineers have the happy faculty of turning out good sets incorporating the latest technical advances, for a little lower sum than the next fellow. This hallmark is observed in the new Crosley mantelpiece receiver, the "Super Buddy Boy" illustrated in Figs. A, B and C.

Before considering the many electrical and mechanical refinements embodied in the design, the outstanding features are to be noted. The tubes required for this set are two type '35 tubes, three '24s, one '47, and an '80. These few words tell the whole story to the technician; that of ultra-modernism in radio set design. Referring now to the schematic circuit, Fig. 1, we find that V1, one of the new type '35 tubes (first known as the variable-mu, and now variously termed "exponential," "logarithmic," "multi-mu," and "super-control"), functions as a radio- or signal-frequency amplifier. The characteristics of this tube greatly minimize "cross-talk," the two-stations-at-one-time bugaboo of the type '24 screen-grid tube; the latter, however, in this circuit

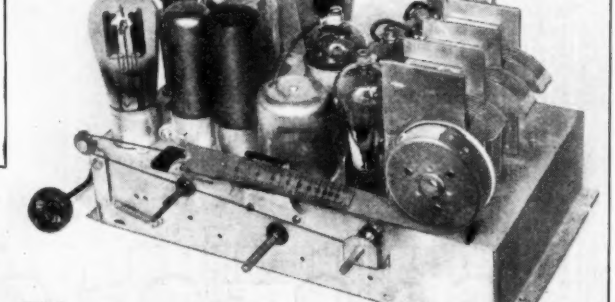


Fig. B
The upper view shows the compact chassis, with the tuning gang at the right: its ingenious flexible tuning scale in the center, and, at the left, the power unit.

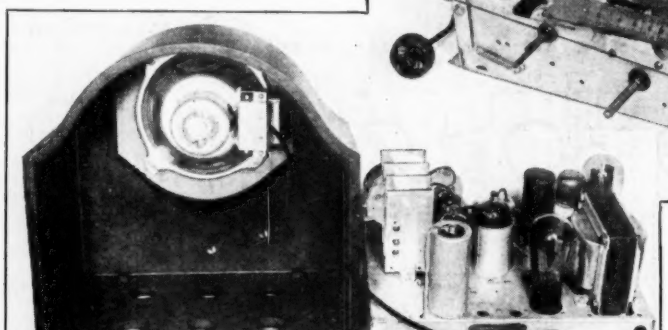


Fig. C (left)
A rear view of the chassis beside its one-piece "repwood" cabinet, the back of which may be used as an antenna for local reception; thus making the whole system self-contained, without aerial or even ground.

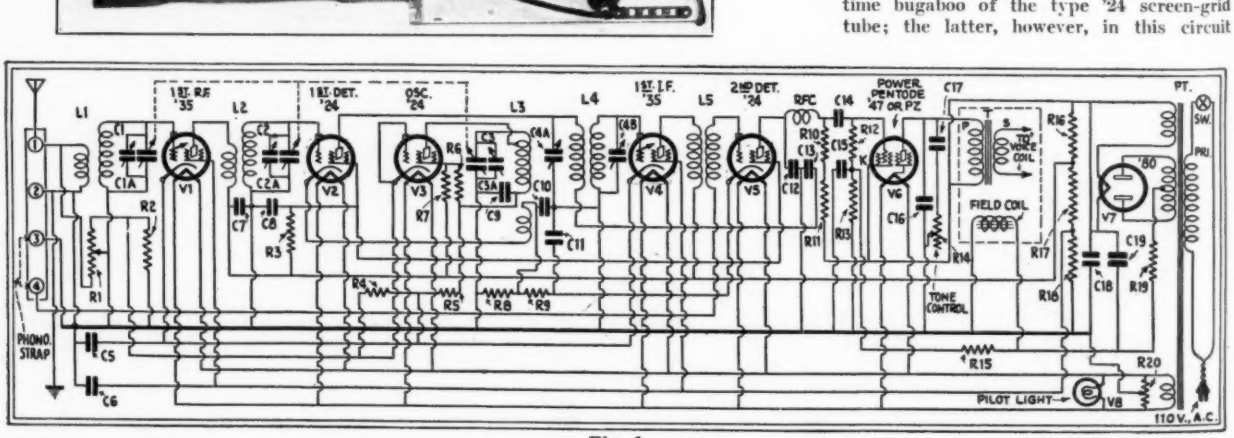


Fig. 1
This seven-tube circuit (and the pentode counts for two stages) gives the immediate impression of a large console set. It incorporates the latest tubes—variable-mu amplifiers, and a pentode output giving a margin of volume on all signals.

serves admirably in the position of first detector, V2. Another type '24 tube, V3, is wired in pliodynatron fashion (See RADIO-CRAFT Data Sheet No. 43, June, 1931 issue. Also, page 536 of the March, 1931 issue) which makes possible an oscillator circuit arrangement that does not require a low-frequency trimmer—good news to Service Men.

The second variable-mu tube V4 is the one and only intermediate frequency amplifier, having tuned input and tuned output circuits. This, adding its compensating action to that of V1, obviates the necessity of incorporating a "local-distance" switch to choose between powerful local, and weak distant, stations—the equivalent action being entirely automatic (See "Recent Advances in Radio Tube Design," in the April, 1931 issue, page 599.)

The last screen-grid tube V5 is the second-detector; note that an aperiodic intermediate-frequency transformer L5 couples the output of V4 to the input of this "screen-grid power detector." The intermediate frequency transformer L4 is adjustably tuned to 175 kilocycles, while L5 is inherently resonant at this frequency.

Our old friend, resistance-capacity coupling, is found joining detector V5 and the last tube V6, which is a power pentode; this combination results in exceptionally fine audio quality, with good volume output at low signal-input levels. (As stated in the May, 1931 issue of RADIO-CRAFT, this pentode's power output very greatly exceeds that of a type '45 tube, for the same control-grid voltage swing.)

Combining the volume control and the off-on switch increases the convenience of operation. Resistor R14 and condenser C17 constitute a panel-operated tone control; the advantage of which in acoustically reducing the effect of "summer static" is now too well known to require discussion.

The high factor of sensitivity of the "Super Buddy Boy" has made it practical to incorporate in the rear of the cabinet a small capacity-type antenna. This plate of cardboard measuring 7 x 16 in., and coated with a conductive substance, is connected to the antenna post on the receiver; and is referred to as the "Tennaboard." The cabinet is modeled "Repwood" in the facsimile of an old English hand-carving, no nails, or glue being used; incidentally, it doesn't warp.

"Illuminated angular-vision ribbon-dial with vernier drive" is the explanatory designation of a new mechanical development, a tuning indicator mounted at 45 degrees to the vertical plane; it renders tuning convenient either in sitting or standing position.

The use of "quantity production" design makes it possible to place on this 7-tube superheterodyne receiver, complete with tubes, a list price under seventy dollars. A dynamic reproducer is included.

And that is not the end of the story! By removing a strap between terminals 3 and 4 on the antenna-and-ground binding-post strip, a high-impedance phonograph pick-up may be connected into circuit; tubes V5 and V6 then function as high-gain audio amplifiers.

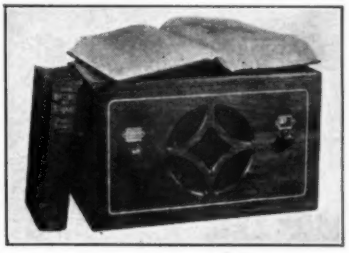
It is the opinion of the writer that the Crosley "Super Buddy Boy" superhetero-

(*Continued on page 44*)

The Summer's Yield of Small Radio Sets

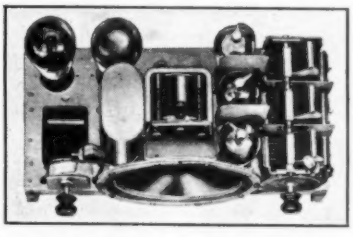
Compactness is still the keynote of production •

A "PERSONAL" RECEIVER



The American Bosch "Model 5A" receiver.

IN the receiver shown here, which must be called an infra-midget, or by some similar superlative, the idea of lightness and portability is carried further than ever before in an electric set of loud-speaker output. It may be tucked under the arm and carried to any desired location without difficulty; yet, small as it is, it contains three screen-grid tubes, a power pentode, and a dynamic reproducer, all with their power supply. How this result is obtained is shown



The chassis of the set shown above has screen-grid (two) R.F. and detector, feeding a power pentode.

in the interior view; the maximum baffling possibilities are realized by the central disposition of the speaker cone. Three tuned circuits, giving good selectivity, are controlled by the tuning knob at the right; the only other control—that for volume—is combined with the switch. The design is attractive by its simplicity, which seems to be almost the ultimate.

(*United American Bosch Corp., Springfield, Mass.*)

A POWERFUL MANTEL SET

The Roosevelt "Model 19" in a mantel-type cabinet.

IN the newest model of the "Roosevelt" line, the manufacturer has introduced the features of variable-mu amplification and pentode instead of push-pull output. One of the special features of the design is found in the use of bank-wound coils of "Litz" wire to give greater efficiency in high-frequency amplification. All late features are included.

(*Commonwealth Radio Mfg. Co., Chicago.*)

TWO MODERN MIDGETS

The Jesse French 7-tube "Devon" super.

BOTH of the compact receivers here shown utilize the latest developments in tubes: the 7-tube "Devon" model being a superheterodyne; and the 5-tube "Tudette," a tuned-radio-frequency receiver.

The French 5-tube "Tudette" midget.

The former utilizes two type '51 variable-mu tubes, one '27, two '24's, and a type PZ pentode. The rectifier is the standard '80.

The "Tudette" mantel set also uses two variable-mu tubes, has a single '24, an '80, and a pentode in the output circuit. A feature is seen in the "full-vision" dial. Both models are equipped with tone controls.

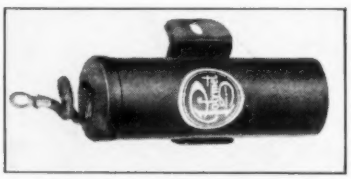
(*Jesse French & Sons Piano Co., Newcastle, Ind.*)

(*Continued on page 47*)

The Latest Radio Accessories and Receiver Components

AUTOMOTIVE FILTER CONDENSERS

AUTOMOTIVE radio reception requires, not only special tubes to stand up under the exacting conditions, but special condensers as well. To bypass the high-frequency currents of the ignition system and eliminate noise, the component type illustrated has been designed with special regard to the high temperature and vibratory impacts which it must undergo. It is desirable to use at least two with a car's electrical system; one between generator and frame and one between the interrupter and



Polymet auto-ignition filter condenser.

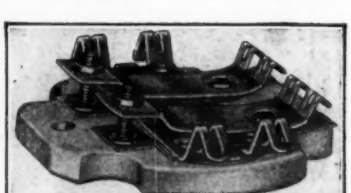
frame, with, of course, the necessary resistors in series with the distributor and spark plugs. The unit shown, used extensively with commercial automotive radio equipment, is made in two capacities, half- and one-mf., 1¼ inches in diameter; the smaller is 2⅛ inches long, and the larger 3½ inches.

(*Polymet Mfg. Corp., New York City.*)

INTERMEDIATE TUNING CONDENSERS

SUPERHETERODYNE vogue has produced a line of condensers, designed specifically for manufacturers' use, but now obtainable by constructors, and intended for mounting to and tuning the I.F. transformers. The capacity ranges are 10-70, 70-140, and 140-220 mmf., in single and double components.

The bases used are of isolantite, an impermeable high-insulation material; the variable plates are of phosphor bronze, specially tested for hardness and temper; and the adjusting screws have specially-cut threads and tapered, self-aligning heads, to maintain their adjustment. The eyelets have fiber "shock pads," to absorb strains and prevent cracking. Terminals are solder-

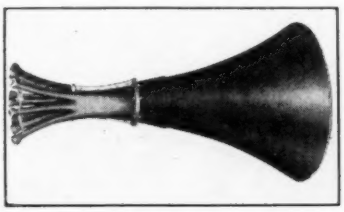


Hammarlund I.F. adjusting condenser.

dipped, as well as cadmium plated, and designed to facilitate soldering without conduction of heat to the plates. The mica dielectric sheets, it is stated, are so rigorously inspected that four out of five are rejected in the selection of the best.

(*Hammarlund Mfg. Co., New York City.*)

MULTIPLE UNIT HORNS



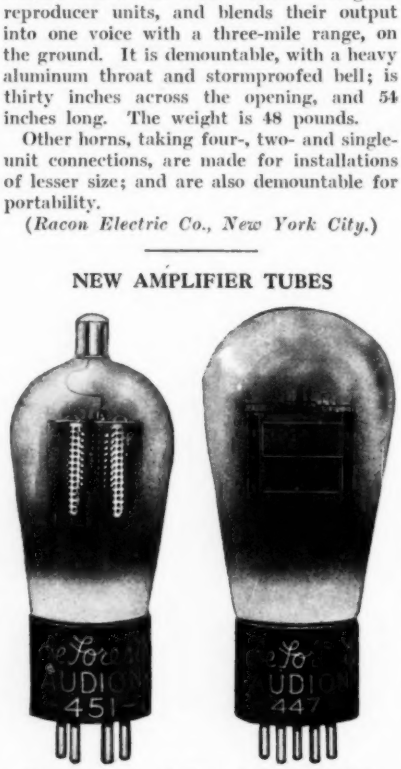
Racon nine-unit reproducer horn.

NO single dynamic unit is sufficiently powerful to meet the demands of public-address amplifiers, such as airports and large assembly grounds require. Of a line of horns designed for such service, the illustration shows one which takes nine giant reproducer units, and blends their output into one voice with a three-mile range, on the ground. It is demountable, with a heavy aluminum throat and stormproofed bell; is thirty inches across the opening, and 54 inches long. The weight is 48 pounds.

Other horns, taking four-, two- and single-unit connections, are made for installations of lesser size; and are also demountable for portability.

(*Racon Electric Co., New York City.*)

NEW AMPLIFIER TUBES



New De Forest Audions: left, 451 variable-mu amplifier; right, 447 power pentode.

MAXIMUM sensitivity, while safeguarding against overloading, crosstalk, and distortion on loud signals, is the purpose of the new 451 "Audion," illustrated here. It operates, like the 424, with 2.5 volts on the filament, drawing 1.75 amperes; the recommended plate voltage is 180, with a plate current of 5.5 ma. at 3 volts control-grid bias, and 0.65-ma. at 20 volts grid bias. The mutual conductance is thus decreased from 1,000 to 80 micromhos, giving complete control of the amplification in receivers which can accomplish this by varying the cathode potential.

With this is announced also the type 447 power pentode, which is intended to give a greater output than is possible with the 445, with the same plate voltage and a smaller input. It has a filament voltage of 2.5; filament current of 1.5; plate and screen voltages of 250; plate current, 32 ma.; with a grid bias of 16.5 volts. The amplification factor is 80, plate resistance 35,000 ohms, and the mutual conductance reaches the high figure of 2,300 micromhos. A UY base is used.

(*De Forest Radio Co., Passaic, N. J.*)

AMPERITES FOR NEW TUBES

THE revival of interest in battery-operated receivers, using highly-efficient tubes of low current consumption, has caused a demand for suitable filament ballast regulators. The manufacturers of the two-volt types have especially urged upon their users that the filament voltage be kept

Amperite suited for 2-volt pentode.

constant; and that this is impossible with fixed resistors in series with a battery supply source the voltage of which changes continually. The well-known self-adjusting rheostat, or "Amperite," overcomes this difficulty. Since it is a current-regulating device, several of the former types will serve for 3-volt batteries; while for 6-volt battery operation, new designs have been made. The type numbers required are (one Amperite for each tube):

Type Tube	Battery 6-Volt	Battery 3-Volt
'30, '32	No. 630	No. 4V199
'31	No. 631	No. 120
33 (Pentode)	No. 633	No. 1A

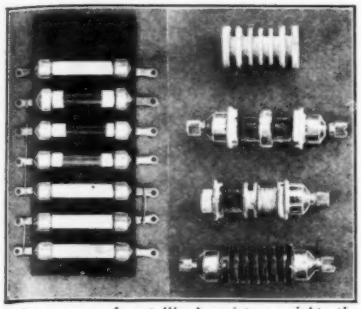
"FEATHERWEIGHT" HEADPHONES

APPLICATIONS of the headphone, in servicing and reception, are still numerous, in police automotive or aviation radio for instance; while in connection with public-address and other amplifier systems for the hard-of-hearing, a comfortable phone is a boon to be sought for. With this in mind, one manufacturer has just produced an instrument of remarkable lightness. The magnet is of a special cobalt steel, held in its bakelite case by clips; the whole phone unit weighs but an ounce and a half, or four ounces for a pair, with light spring-steel

Trimm "Featherweight" headphone unit.

band. The cord is attached to the phone unit and the case in a manner which prevents wear and strain. The standard set has a resistance of 1,000 ohms for each unit.

(*Trimm Radio Mfg. Co., Chicago, Ill.*)



Left, a gang of metallized resistors; right, the making of a wire-wound precision resistor.

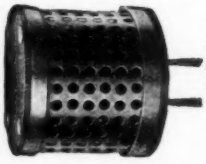
MIDGET RESISTOR STRIPS

NOW that the midget construction is in demand, for even receivers with many tubes, compactness and accessibility are at a premium. These requirements have been met by "ganging" metallized resistors in the manner shown; the various units are mounted on the strip by passing through it the tips of their leads, and crimping them to soldering lugs. Such units, of course, are made up to meet the demands of the receiver for which they are intended.

The remainder of the illustration shows the method of building up precision wire-wound resistors. The wire used is of nickel alloy, of a cross-section as large as the resistance value permits, specially enameled, and tested through mercury contacts to determine the completeness of the insulation. It is then wound in the slots of the ceramic (porcelain type) base, and impregnated with a special varnish which hardens at high temperatures. The resistors are again tested by five-minute flash loads; and then on accurate bridges to determine their accuracy, which may be from 1% down to a quarter of that figure.

(*International Resistance Co., Philadelphia, Pa.*)

VOLTAGE REGULATOR FOR MIDGET SETS



The Clarostat 50-watt line-voltage regulator has been developed for the benefit of owners of "midget" sets.

MANUFACTURERS and Mr. Ultimate Consumer will be interested in the new "Clarostat" automatic line-voltage regulator, in diminutive (50-watt) size, designed especially for midget radio sets.

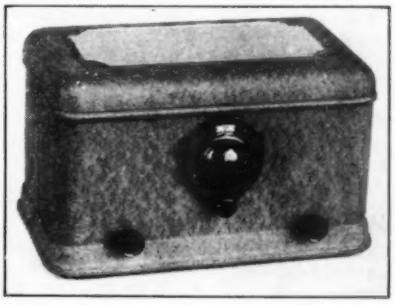
Service Men contemplating the use of this resistor will be interested in the voltage drop to be expected when it is inserted in series with the input to the primary of the power transformer; this is dependent, in part, on the power requirements of the particular set, as follows: 0.45-amp., 10 volts drop; 0.5-amp., 13 volts drop; and 0.6-amp., 20 volts drop. The unit is 1¾ inches in diameter, and 1¾ inches long, with two prongs extending another ⅝-in.

Although intended only as a voltage regulator in the primary circuit of the set, it will function also as a fuse in sets not provided with one. Of course, such fuse is

(*Continued on page* 41)

The Walker "Model 4" Short-Wave Super-Converter

THE superheterodyne converter has already won for itself a commanding place by the facility with which it provides efficient short-wave reception, when used in connection with the standard broadcast receiver which every up-to-date household now possesses. The latter instrument is designed for reproduction of good quality on long-wave stations within a reasonable listening area; it remains only to provide the necessary means of tuning to the rapidly-increasing number of short-wave broadcast stations throughout the world.



George W. Walker's latest converter is housed as befits a modern receiver.

This, with all simplicity of operation and the sensitivity required to pick up signals from thousands of miles away, is now obtained through the modern unit pictured here—the Walker Super-Converter, which tunes over the band from 14 up to 200 meters, and uses as its intermediate and audio amplifiers any standard receiver, of whatever type and method of operation. The Super-Converter acts simply as a pre-amplifier and frequency changer, feeding into the receiver a modulated radio-frequency signal which is within the tuning range of the latter. Only a single external connection to the broadcast receiver is required, as the Super-Converter is self-contained.

It includes an oscillator and first detector, using type '27 tubes, as well as a stage of screen-grid R.F., using a '24 tube, ahead of the detector—to increase the amplification, prevent radiation and permit use of most any antenna length. (The signal is picked up by the converter and passed on to the receiver for additional amplification, thereby utilizing each circuit of the receiver and making unnecessary the purchase of an extra speaker or the erection of a special antenna.) An '80 rectifier is used in the power pack.

The receiver is not disturbed; since there is no need to "plug in" to furnish the power necessary to operate a converter; a connection is made from the converter directly to the antenna post of the receiver. There is no overloading of the receiver's power supply, for the Walker Super-Converter draws its power directly from the electric light socket. There can be no possible damage to the receiver.

Regeneration in the detector circuit, as shown in the schematic circuit, Fig. 1, provids a degree of sensitivity and selectivity otherwise unattainable; it has been credited with the efficiency of an additional tube. Where is there a "dyed in the wool" short-wave fan who does not insist upon regeneration? The oscillator and detector tuning condensers are ganged and, necessarily, provided with a fine vernier dial for sharp tuning. A small midget condenser, used as compensator, connected in parallel with the oscillator condenser, permits resonance at all wavelengths. All tuning is accomplished with the vernier dial, and with the aid of the midget compensator, insures maximum selectivity. "Hand capacity" is noted by its absence.

In addition to hearing far-distant short-wave programs, there is the thrill of tuning in broadcasts of police departments throughout this country and Canada. The personal transoceanic telephone conversations have also proved interesting to those inclined to "listen-in." Short-wave fans have no fear of warm weather reception. The reduction of static, plus the long range and penetration of short-wave broadcasts, will prove entertaining in the hottest months when your local programs may be disturbed by crashes of static.

(*Continued on page* 41)

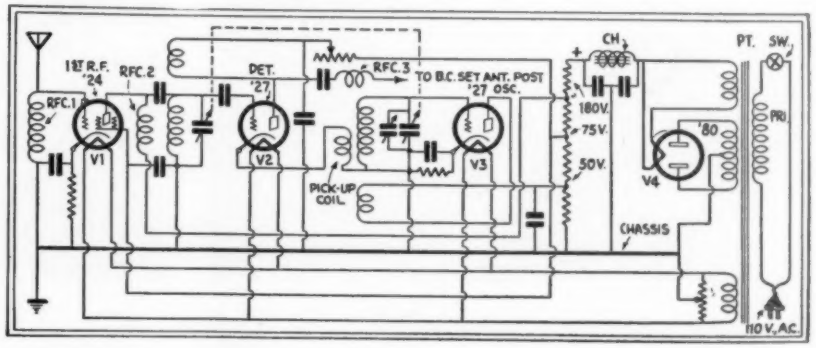


Fig. 1

The schematic circuit of the "Model 4" Super-converter, which operates as a frequency changer. It has its own power supply and is connected to the receiver only at the antenna post.

Introducing Our

The mechanical and electrical the "Iron Man" which is such public, and is making big

By H. G.

IN radio, as in almost every other field, productive originality is amply rewarded in dollars and cents. A clever New York radio engineer, Mr. Paul Von Kunits, has created "Mr. Radio Robot," a remarkable device which is attracting unusual attention and proving a source of profit to its originator.

The idea is passed along in this article, with complete details, to other radio men, as "Mr. Radio Robot" can undoubtedly be used to advantage in many towns and cities throughout the country.

The cover illustration gives an excellent idea of the appearance of the "Iron Man." From a theatrical costumer was procured the coat of mail used to represent a medieval armored knight. Such ensembles are fairly common, since they are extensively used for masquerades, and they can be rented or purchased at a reasonable price.

Before giving details as to the construction and actual mechanism of the robot, some of the startling things he can do may be mentioned. In response to a pre-determined series of whistled notes, or the whistling of a given tune, "Mr. Radio Robot" will stand up, sit down, move his left arm or his right arm, turn his head, fire a gun, start to talk, etc.

He will also go through a definite series of operations, which may be worked out in advance. For example, in response to a command in a certain tone, the "Iron Man" will stand up, move his head, make a speech, lift either arm to emphasize certain points, bow at the end of the speech, and then sit down. While he is talking, his eyes and teeth will be illuminated with a light of fluctuating brilliancy.

Furthermore, this robot will answer questions intelligently; and can be used to make announcements and to entertain with the latest song or other musical selections. If desired, "Mr. Radio Robot" can be made to go through the various mechanical motions by means of switches or push-buttons located at a distance; or manual and audible control may be dispensed with and he may be actuated through the mere interruption of an invisible ultra-violet beam. Thus an arrangement is possible, whereby he will fire a gun, or stand up, or start to talk—if someone walks past him.

In the cover illustration, the robot is shown answering questions put to it. There is a reproducer concealed in its chest; and a microphone (within it) at a distance of about five feet from the ground and therefore on a level with the mouths of people asking the questions. The operator and the portable amplifier may be located at any convenient point, no matter how far from the robot. It will be noted (Fig. A) that the operator uses a headset and that he talks into a microphone. Its adjustments are made on the small control box in front of the amplifier.

A portable power amplifier is used for this portion of the set-up. The two microphones, the loud speaker and the headset are connected as shown in Fig. 1. Complete portable amplifiers are available for this type of work; one of the most suitable ones being the new Electrad Loftin-White Portable Amplifier.

Fig. A

This inscrutable, armored figure stolidly moves his head, his arms, and correctly answers questions put to him—a seemingly human Iron Man. (Mr. Cisin, wearing headphones, is at the controls.) The reference letters indicate: A, pulleys and reproducer; B, microphone M1; C neon tube which lights the eyes; D, head and arm motors; E, selectors, relays, and amplifiers; G, microphone control box; H, additional amplifiers; I, microphone M2.

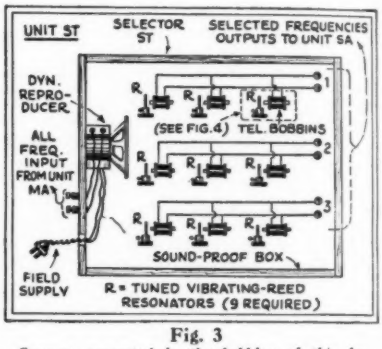


Fig. 3

Current generated in the bobbins of this frequency-selector when the tuned reeds vibrate with the loud-speaker signals, is later amplified.

Giving Commands by Sound

Fig. 2 is a pictorial layout of the signal-selector system, whereby a pre-determined series of notes of different pitches and timbres are used to actuate the mechanical man. Examining the layout from left to right, it will be noted that the microphone M1 (the one concealed within the robot) is connected to a microphone control box (G, in Fig. A.) This connects to the input of a high-quality amplifier, such as an Electrad direct-coupled Type A-245 unit, Fig. 4A. The output of this microphone amplifier, connects to a three-section selective tuning device ST, which is the portion of the apparatus that picks out or responds to the particular actuating notes or tones.

The output of the "mike" amplifier (MA, Fig. 2) is connected directly to the voice coil of a small dynamic reproducer, mounted within a sound-proof wooden box (ST) containing nine differently tuned vibrator reeds. There are nine electromagnets, one in front of each vibrator reed; three of them being connected in parallel on each of the three electrical circuits, as shown in Fig. 3.

When a note of the required tone and pitch is sounded or whistled before the microphone M2, the microphone amplifier MA magnifies the impulse sufficiently to actuate the speaker. The amplified sound coming out of the speaker causes the reed which is tuned to correspond to this one note to vibrate; this, in turn induces a feeble current within the electromagnet placed before it.

By varying the position of the magnet, with relation to the vibrating reed, it is

Mr. Radio Robot

details of the construction of an object of interest to the money for his constructor.

CISIN, M.E.

possible to pick off either the *fundamental*, the *second harmonic*, or the *third harmonic*, as clearly illustrated in Fig. 4. Incidentally, the reed will respond also to notes either one or two octaves higher than the fundamentla.

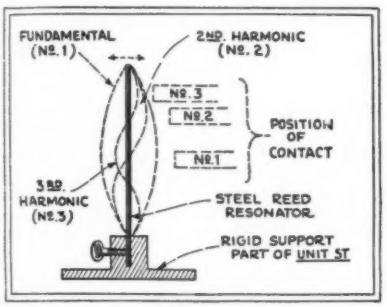


Fig. 4

A "corset steel" may be used in making this portion of the tuned relay. Moving the bobbin may raise the pitch (positions 2, 3.)

The feeble induced current flows into the corresponding selector-signal amplifier SA. There are three of these amplifiers, one for each of the three circuits. (Electrad Loftin-White A-245 amplifiers may be used for this purpose; the circuit connections are shown in Fig. 4A.) The main function of these amplifiers is to give voltage amplification and hence a "space-charge" amplifier having a screen-grid tube and a '12A tube would serve the purpose. (See Fig. 4B.)

The output of each amplifier goes to a separate rectifier R. Details of the rectifier circuit, which is very simple, are shown in Fig. 5. Rectification is accomplished by means of a '12A tube. The rectified current then goes to the "time-delay relay" TDR. The plate voltage required on the '12A tube will depend upon the type and characteristics of the time-delay relay.

If it were possible to obtain a comparatively pure note at the microphone (for instance, by the use of a flute), the time-delay relay would not be necessary. In the case of a whistled note, however, strong harmonics and overtones are present, which cause the reed to "chatter." The time-delay relay overcomes this trouble, preventing continued vibrations.

Controlling the Relays

The output of each time-delay relay (TDR, Fig. 5A) goes to a corresponding heavy-duty circuit-breaking relay RC. A common 6-volt battery actuates three heavy-duty relays. See Fig. 6.)

Each current impulse through a heavy-duty relay HDR attracts a pivoted armature. As the armature is drawn towards the magnet, it operates a ratchet through a lever system; causing a heavy notched brass wheel W (No. 1, 2, or 3) to turn one notch. A spring pulls the armature back until a second impulse again causes the brass wheel to be turned another notch. If the correct number of whistled signals are given, it will turn until the copper strips A, B and C make contact with the brass studs fastened on its side. Before it is possible to actuate the heavy-duty master relay HDMR all three wheels must be turned the right number of notches (since the three circuits are in series.)

The action is analogous to that of a Yale lock, or to the opening of a safe. Unless the correct, pre-determined notes are sounded, and unless the correct *number* of notes are sounded, "Mr. Radio Robot" will fail to respond. Since three distinct fundamentals are available on each of the three circuits (not to mention the second and third harmonics available by changing the placement of the electromagnets, as shown in Fig. 4), it is apparent that the "Iron Man" may be arranged to respond to a certain melody, or a song containing the correct sequence of pre-determined notes.

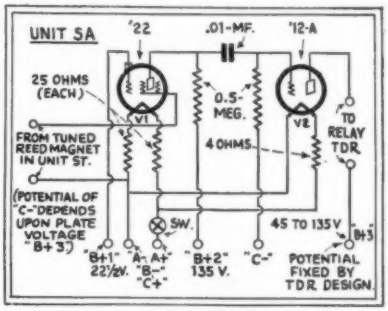


Fig. 4B

The selector amplifier; a "space charge" circuit is shown. The output operates a time-delay relay, Fig. 5A.

Once the circuits "A," "B," and "C" shown in Fig. 6, have been closed, the heavy-duty master relay is actuated. This is operated by the 6-volt battery, shown for the sake of clarity as a separate unit; in actual practice, the battery used for the time-delay relay may also be used for the heavy-duty master relay and for various other relays requiring six volts, as shown in Fig. 1.

The heavy-duty master relay is used to close any desired specific circuit; such as the one causing "Mr. Radio Robot" to rise, or to fire a gun, to make a speech, etc. Details of the mechanical-motion circuits are shown in Fig. 7. The robot is equipped with two Ford fractional-horsepower starting motors, and with a number of Knapp toy motors ("series" motors are used in order to supply the necessarily high starting torque). The Ford starting motors are used to make the robot stand up and to fire the gun; while the toy motors perform the lighter tasks of moving the head and arms. Three wires are necessary in the circuits from the motors, in order to reverse their direction when required. Merely changing the polarity will not reverse the direction of these motors, and it is therefore necessary to reverse the current direction in the armature, without changing that in the motor field.

The Robot's Stunts

A mechanical stop prevents the motor from turning too far. For example, in order to make the "Iron Man" stand up, the motor can turn over only a certain amount; reversing the motor causes him to sit down. This motor (along with most of the relays) is mounted in the platform below the robot. In turning, the motor pulls two cords, which pass over pulleys in the knees, and which are fastened within the figure at the rear waist line. Tension on the cords promptly brings the "Iron Man" to his feet. Similar ingenious arrangements

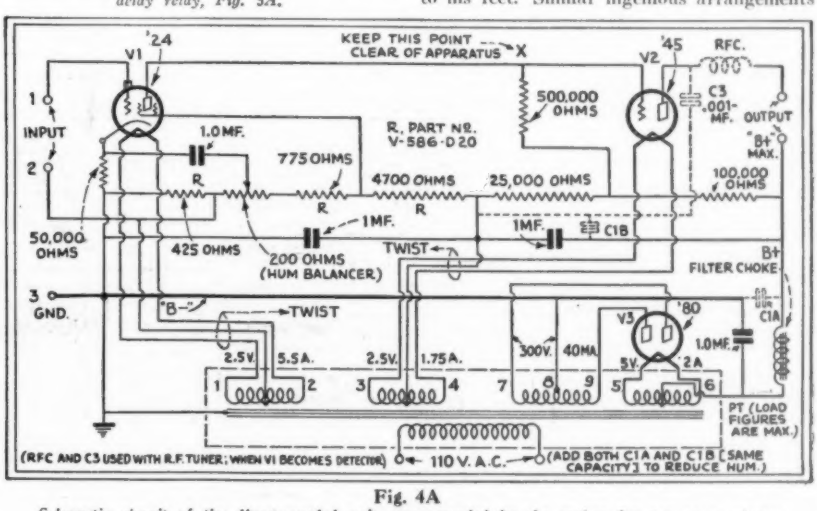


Fig. 4A

Schematic circuit of the direct-coupled unit, recommended by the author for use as a selector amplifier. The number of amplifiers used is determined by the desired number of actions; three being described by the author and illustrated in Fig. 2.

of cords, pulleys and levers produce the various other mechanical motions.

The most mystifying effects are produced through the use of a light-sensitive cell; this is mounted in an unobtrusive position, with a light-source constantly directed upon it, except when the light is obstructed by someone passing in front of "Mr. Radio Robot." (It is possible even to use an ultra-violet ray, which is invisible and hence still more dramatic). As long as light falls on the cell, no appreciable current flows but, as soon as the light-source is obstructed, there is a sudden increase in current, sufficient to actuate the relay. Of course, it may also be connected in such a way that the reverse action will take place. That is to say, the relay may be actuated by an *increase* of light instead of a decrease—for example, by permitting the light source to strike the cell only when it is desired to operate the relay.

Business Possibilities of the Robot

The commercial possibilities of "Mr. Radio Robot" are tremendous. He may be rented to stores which are carrying on special sales and advertising campaigns; or he may be used at entertainments, fairs, bazaars and for a great variety of purposes. In New York, the "Iron Man" was recently leased to a large furniture store on East 57th Street. The portable amplifier was set up at the rear of the store; and announcements, made from the microphone at that point, were amplified and reproduced through the speaker within the robot. At stated intervals, the "Iron Man" answered questions; and, between times, the latest song hits were reproduced by means of the electric phonograph. Although the original contract was for only one week, the robot was so successful in stimulating business, that he was held over for three entire weeks.

Since the idea was first conceived, "Mr. Radio Robot" has been in continuous use, and now has more advance engagements than a popular vaudeville star!

The entire device needs practically no servicing, once it is set up, and consumes very little current while in operation. It can be operated by a store manager or sales person and does not require a skilled attendant. Those who contemplate the construction of a robot can make the device comparatively simple at first, and afterwards make it more intricate from time to time. For instance, it may be desirable to start out with the portable-amplifier outfit for answering questions, making announcements and playing records. Later on, the relays and mechanical action may be added.

This flexibility is a great advantage and is a point which should not be overlooked by the radio man who may be deterred from starting the construction of a robot, because of imagined complexities.

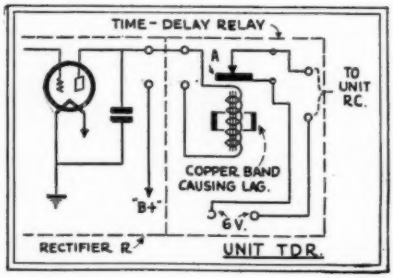


Fig. 5A

This relay gives a delay of about a minute; its winding is connected in series with the plate circuit of a rectifier (Fig. 5).

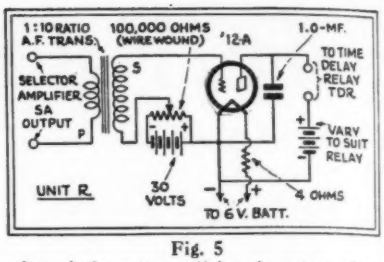


Fig. 5

One of the units rectifying the output of a selector unit (Fig. 3).

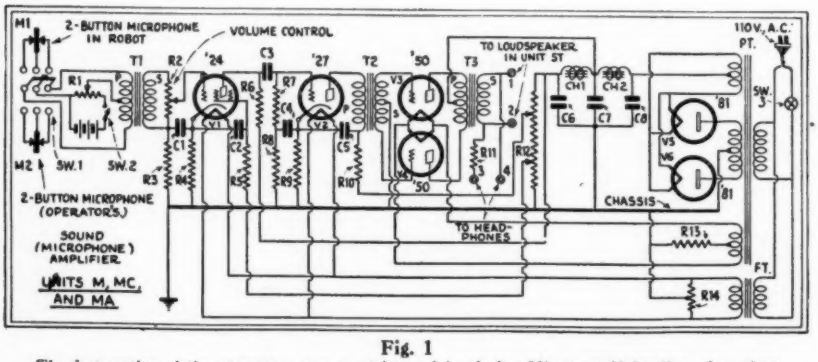


Fig. 1

The first section of the apparatus; care must be used in placing M1, to avoid howling, since there is a reproducer in the figure. The operating potentials demand high-rating filter condensers. R11 may be variable, to adjust the sound level in the headphones.

LIST OF PARTS

(Units M, MC and MA, Fig. 1)

One three-pole, double-throw switch, Sw1;
One single-pole, single-throw switch, (Sw2, operated by R1);
One single-pole, single-throw snap switch, Sw3;
Three dry cells (1.5 volts);
One Ferranti "Type AF5M" microphone transformer, T1;
One Ferranti "Type AF5C" push-pull input transformer, T2;
One Ferranti "Type OP1C" (for direct coupling to 8000-ohm line speaker) or "OP25C" (for dynamic speaker) push-pull output transformer, T3;
One Electrad 200-ohm potentiometer (and switch Sw2), R1;
One Electrad 0.5-meg. "Royalty" potentiometer, R2;
Two Durham 50,000-ohm (1-watt) "metallized" resistors, R3, R8;
Two Electrad 2,000-ohm "flexible" grid resistors, R4, R9;

(*Continued on page 46*)

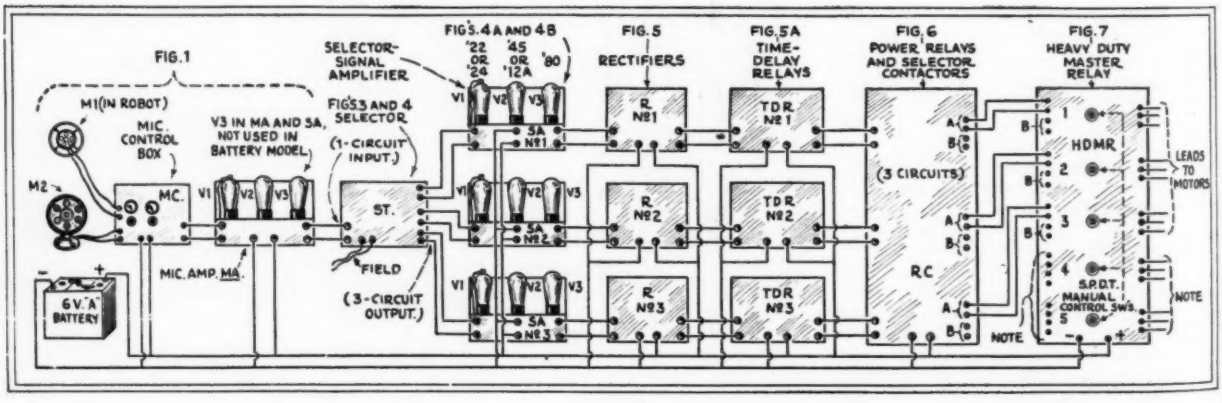


Fig. 2

A layout of the units shown in detail in the detail sketches, as noted at the top. Most of these units (except those of No. 1) may be concealed in the base beneath the robot. The binding posts 4 and 5 in the unit of Fig. 7 (at the right of this diagram) are for additional controls and motors.

How to Improve the Quality of Radio and Personal Recording

Instructions for operating the microphone, amplifier and cutter, and for the choice of records

By GEORGE J. SALIBA, S.B.

THE radio amateur of the olden days had no criterion by which to measure the results he obtained. His home-made radio receiving set (or "wireless receiver" as it was called in those days) was capable of receiving code signals very clearly; and, when broadcasting came, the music and speech were clear and intelligible. The amateur did not worry about *fidelity*. His magnetic horn or cone was not nearly as efficient as the present-day dynamic reproducer; but he was satisfied with it because he had heard nothing better.

With the home recordist the story is reversed. For years he has been listening to commercial phonograph recordings of such quality that they are hard to distinguish from the living artist. When, therefore, he starts to record he has a criterion by which to judge his results; and for this reason his first few results will appear to be unsatisfactory. Yet he is not up against the difficult problems with which the radio ham has had to contend. All recording systems are fundamentally the same. Sound is put into a microphone where it is converted into small electrical currents; these are then amplified and transmitted to a cutting head. It is very important that *every component* operate at maximum efficiency to insure good records.

The different integral units will be discussed later, in detail, and the precautions to be observed in the operation of each will be pointed out; while the most common complaints of home recordists are the following:

(1) Volume of reproduced record low;
(2) Inability of reproducing needle to track;
(3) Needle jumps record when recording;
(4) Sound distorted;
(5) Sound comes in loud, then dies down;
(6) "Echo" in the reproduced recording;
(7) Record off pitch.

Complaints 1, 4, and 5 are common to the pregrooved record and the blank uncut disc.

The volume of the reproduced record may be low from any one of several reasons: incorrect microphone technique; lack of gain in the audio amplifier system; either insufficient, or too great, weight on the cutting head.

Distortion of sound may be due to too much amplification; improper impedance matching between the microphone and the amplifier, or between the amplifier and the cutting head; or to shouting into the microphone.

If the sound comes in loud, and then dies down, it is practically certain that the microphone is "packing."

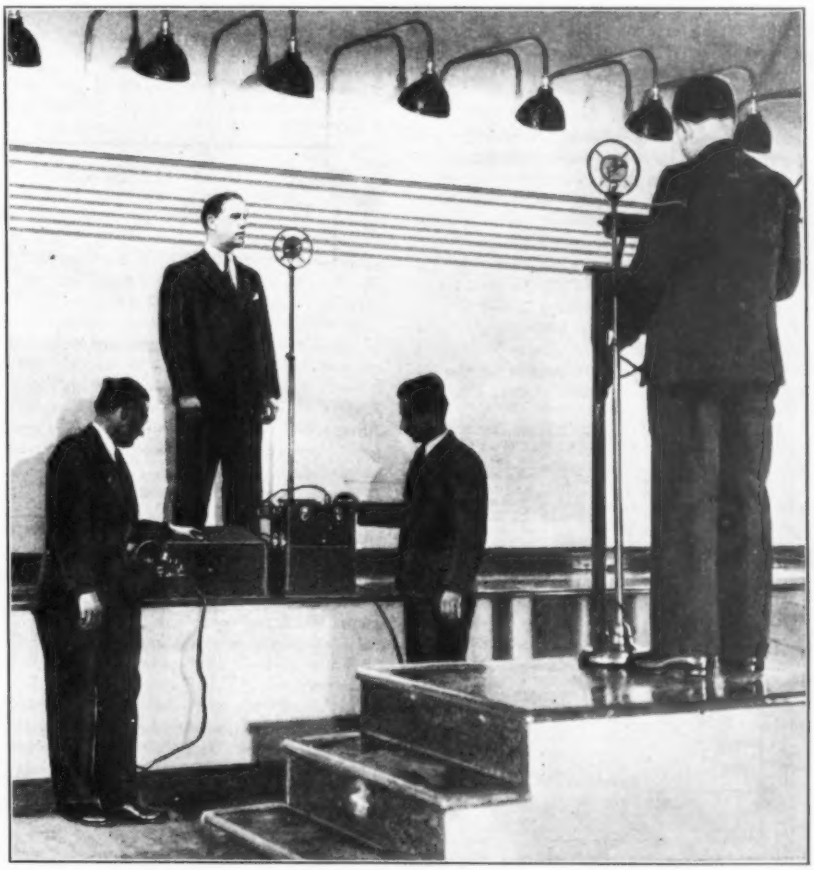
The remedies for these troubles will be considered under their proper headings.

Microphone Technique

Too many records are spoiled by incorrect use of the microphone. Fig. 1 is the schematic diagram of a single-button microphone circuit, and Fig. 2 that of a two-button microphone hook up. In Fig. 1 the milliammeter is placed in series with one leg, and the microphone current is varied by means of the potentiometer "P"; the values of this current is determined by the type of microphone used, and this information is usually supplied with the instrument. (Interesting data on microphone amplifiers appeared in the article, "A Public-Address Amplifier Unit, in the October, 1930, issue of RADIO-CRAFT.—Tech. Ed.)

If a two-button microphone is used, jacks in each button leg, as shown in Fig. 2, will be necessary. Some people connect the meter permanently in the center leg, to read the sum of the two currents, but this is a risky procedure. If the microphone is rated at 20 mils *per button*, the middle leg will carry 40 mils. With the meter in the center leg reading 40 mils, one button may be packed and carrying 30 mils, while the other carries only 10 mils. The result will be that the button carrying the 30 mils will pit and burn out. For the same reason it is inadvisable that the meter should be placed permanently in *either* leg. The ideal way of keeping close watch on the current is to have a meter in each leg, but this means added cost.

If the speaker, or singer, stands too close to the microphone the reproduced record



A sound installation demonstrated at police headquarters, New York City, for the famous "line-up." Conversations between the inspector (right) and the "suspect" posed before the lights, would be recorded. Mr. Saliba (left) and E. M. Shiepe (center) are operating a portable recording apparatus. (International News Photo)

will be loud and possibly distorted; even if there is no distortion, the quality will be poor. The effect will be "tubby" and stifled, as when talking into a partly filled barrel. On the other hand, if the distance from the microphone is too great, the volume of the record will be low. It is best to stand about 10 inches from the microphone, and the voice should be directed *into* it. If it is necessary to stand closer to the microphone, the person should face the instrument and direct his voice *past* it. At no time during the recording should the current be changed by the operator; otherwise a crackling noise will be registered.

If the current should suddenly rise, it is an indication that the microphone is packed; this usually happens on particularly loud notes. The pressure causes consequent lowering of the resistance. The microphone should then be tapped lightly, to spread the granules.

When starting to record, the full microphone voltage should never be applied suddenly; it should be brought up *gradually* until the milliammeter reads the normal current. A little time may elapse, while the microphone is warming up, before the button current readings stabilize.

It will be found that the use of a two-button microphone will result in much better recordings than a single-button type. At best, the single button will not pass frequencies higher than 2500 cycles; while the two button will easily pass 5000-6000 cycles. If the recording system is to be used for voice only, then a single-button microphone will be sufficient.

The Amplifier and the Motor

In the radio sets of today, where the gain in the R.F. stages, due to the use of screen-grid tubes, is so high, only two stages of A.F. are generally used; and sometimes, a "power" detector is followed by only a single output (power) stage. The use of such an audio system is unsatisfactory for recording, unless one is willing to stand very close to the microphone and shout into it. If the radio set has one preliminary audio stage feeding the power stage the results will be fair; but still the person at the microphone will have to stand close. For consistently good records, one must depend on a three-stage amplifier, preferably of the transformer-coupled type. Fig. 3 shows a single-stage amplifier which was used ahead of the two-stage audio amplifier of an Atwater Kent "Model 55" receiver.

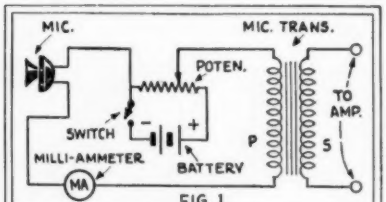


FIG. 1

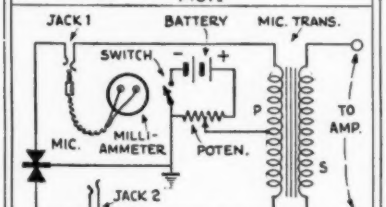


FIG. 2

Above, connections for the adjustment of a single-button microphone; below, those for a double-button hookup. The current in each "leg" of the latter should be checked separately.

A motor of at least 20-watt rating should be used, especially if records are to be made on uncut blanks. A motor of this rating is powerful enough to make an 8-inch record but, if a larger record is desired, a 25 to 30 watt machine should be used. These motors are now obtainable from the manufacturers.

When recording it is very essential that *a stroboscope* (See page 636, April, 1930 issue of RADIO-CRAFT) be used; and the speed of the motor should so be adjusted that the table is running at 78 R. P. M. *with the cutting head in position on the record, and cutting.* When the lines on the stroboscope appear stationary, it is an indication that the table is running at the proper speed.

If the records are made with the motor running at less than 78 R. P. M., the playback will be off the pitch until the turntable is adjusted to the same speed at which the record was made.

Do not entertain the idea that the motor is O.K. if it is strong enough to pull the record. It might, and will, reach normal speed when the record is about half finished; but, on playback, the first part of the record will be off pitch, while the last part will be O. K. While six- or seven-inch records are used, the average commercial phonograph motors will be found satisfactory.

The Cutting Head

The ordinary phonograph pick-up has been found fairly satisfactory for home recording but, nevertheless, it has its limitations. In commercial recording, the cutting head is given a response-characteristic, as shown by curve A in Fig. 4. (The only function of the true recording head is to receive power from the amplifier and, in turn drive a mechanical recording stylus.) This recording head operates in a *linear* fashion over nearly the entire range of amplitudes involved in speech and music; although, as indicated in Fig. 4, the response falls off below about 250 cycles. It is necessary to have this falling characteristic (volume reduction) to prevent double tracking when recording the lowest notes.

In order to compensate in the *reproduction* for this "falling" characteristic, practically all pick-ups are designed with the "rising" characteristic shown by curve B (Fig. 4.)

Let us consider the use of a regular phonograph pickup, hooked up backward for recording, instead of a commercial recording head, compensated for the mechanical limitations of the disc, as stated above. Then, the low-frequency response would be, approximately, as shown dotted at C; and, with the same pickup connected as a reproducer, this high volume level recorded

Thirty Dollars for 3 Words

EVERY so often, in the development of an art like radio, new descriptive words are urgently required; and, as a rule, the trade itself seeks to supply them.

In putting it up to the readers of RADIO-CRAFT to coin three new terms which are urgently required, we are in hopes that our readers will find exactly the right titles to fill the blanks:

(1) The Professional operator of recording equipment should be called a .....? (A word hitherto used, but which fails to quite fill the bill, is "Recordist.")

(2) The Non-Professional owner of a recording radio receiver is a .....? ("Home-Recorder" is not sufficiently definite.)

(3) The person whose voice is actually being recorded is a .....? (While "Recordee" or "Speaker-In" might be used; neither seems satisfactory.)

The terms quoted above do not seem fully suitable; so you will not send them in. However, we are sure that, among our thousands of readers, there is someone to find exactly the right word to cover each of these ideas.

Here are rules, read them carefully.

Each word should be euphonious (that is, sound well) and be short rather than long. It must, of course, express the specific idea as correctly and distinctly as possible.

Write your entries for each word on a separate slip of paper; do not mix No. 1, No. 2, and No. 3. Each should be of a size to go in an envelope without folding; or you may use postal cards, also separate for each entry. *Do not enclose these entries with any other communication,* or they may be mislaid.

The contest closes June 30, 1931; entries postmarked after that date will not be accepted. All letters or cards must be addressed to *New Word Editor,* RADIO-CRAFT, 96-98 Park Place, New York, N. Y. We cannot enter into correspondence about entries.

All employees of the Techni-Craft Publishing Corporation, and their families, are excluded from this contest.

The three contests are separate; the prize for each winning word will be awarded without reference to whether or not the winner submitted entries for the other two. If two or more persons submit, for the same one of the three definitions, the identical word which is selected as the most suitable, each will be awarded the full amount of the prize offer for one contest—$10.00.

Checks will be mailed on publication to the three prize winners, to be announced in our September, 1931 issue.

at the lower registers would result in accentuated bass reproduction, as indicated at D (providing, the record does not double-track).

It is thus evident that the phonograph pickup is not the ideal instrument for home recording. The tendency to cut over from groove to groove at the lower frequencies is very great and, when using a phonograph pickup, for recording, volume must be sacrificed in order to prevent this cutting over. However, "cutting heads" are now available on the market at a slightly higher cost than

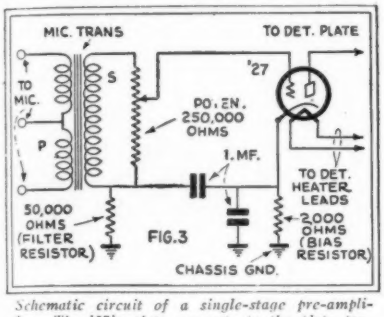


FIG.3

Schematic circuit of a single-stage pre-amplifier. The '27's plate connects to the plate terminal on the detector-tube socket. Unless a "power detector" is used, the "B" voltage must be increased to 90 v. or more.

pickups; these cutters are really like the regular phonograph pickup, *but properly damped to simulate curve A.*

The problem of properly matching the impedance of the recorder, to the output of the amplifier, *is very important in the making of good records.*

Most phonograph pickups are of the high-impedance type and can work directly off the plate of the power tube. If the pickup is of the 200- or 500-ohm type, however, an impedance-matching transformer is necessary. Some manufacturers have tried marketing a low-impedance (12--15 ohms) recording head, made to work from the voice coil of the dynamic speaker; but the impedances of the voice coils, in different radio sets, vary from 2-18 ohms and, consequently, the high-impedance cutter was resorted to.

The Pre-Grooved Record

Before the troubles of pre-grooved records are diagnosed, the theory of this type of record will be discussed briefly.

This type of record has 78 or 80 lines to the inch, as against the eventual 92 or 96 per inch to be scribed in the disc which is furnished blank and ungrooved. The groove is very narrow and merely serves the purpose of guiding the cutting head across the face of the record. When the needle is placed in the groove and pressure is applied, the groove is spread to almost twice its original width. (See Fig. 5.)

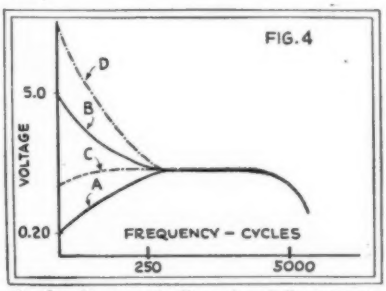
As Fig. 6 shows in more detail, when the needle is vibrated a new, wider groove is made to correspond in its fluctuations to the tonal modulations impressed on the input of the amplifier. When the connections are changed over for reproduction, the playback needle follows this wider groove, and the vibrations are again converted, first into electricity and then into sound. It is quite evident that, if there is not ample space between grooves, a heavy bass note will cause the needle to "double track," or cut over into the next groove, and spoil the record.

When the cutting needle refuses to stay in the groove during recording, the fault can be traced to one of two sources: either the volume is too great or the weight is not enough. Add a little more weight to the head, until the fault is corrected, and then record. If the reproduced record is distorted, the trouble is due to too much amplification. One or two experiments will usually locate the trouble.

When using pre-grooved discs with more than 80 lines to the inch (fortunately, few are available) the volume must be watched very carefully; otherwise, echo will be heard in the finished product. Before these records are used, they should be carefully wiped clean to remove all foreign particles and, if it is found that some of these records have "surface noise," the application of a few drops of ordinary lubricating oil will usually reduce the "surface."

Recording and Playback Precautions

Not every kind of aluminum is good for recording; the grade that is used is of a certain hardness and the discs are first polished to a mirror-like finish. Then a wax film is spread over the surface and rubbed right into the disc, thus filling up all the pores. It is important that only this specially-treated aluminum be used; otherwise the results obtained will be unsatisfactory. (The Remsen disc is an example of this type, in which the groove is made by compressing the metal. No material is removed, thus preventing surface noise.)



In the above graph, lines A and B represent respectively the voltage characteristics of commercial recording heads and playback pickups. At C is indicated the use of a pickup for recording; and, at D, the resulting distortion when using the same pickup for playback.

Sometimes, when recording only on one side, it is found that the disc has warped slightly, and difficulty will be experienced in making the needle track. This can be avoided by either recording the other side or cutting a blank groove therein.

The inability to track may also be due to several other reasons; if the tone-arm is tilted a bit, or the turntable is wobbly, this will prevent the needle from following the groove. If the recording has been made at a high volume level, some of the grooves will cut into each other; and this also will prevent the needle from tracking.

Only two types of needle should be used to play back aluminum records—namely, fibre and thorn. The use of any type of steel needle, aside from introducing considerable surface noise, will ruin the record.

Do not be too ready to condemn aluminum records until you have made sure that the needle with which you are playing back is sharpened to a fine point. The thorn and fibre needles should never be used more than once or twice before resharpening with a piece of emery board—that is, a finger-nail board!

The angle which the reproducer makes with the record has a great deal to do with the life of the needle point, and an over-heavy reproducer will very rapidly wear out needles. Therefore, it is very important that the needle be examined thoroughly before each playback.

Home recording is a new art—an addition to radio which is here to stay; but to obtain good results, one must be patient and willing to do just the least bit of experimenting. Do not be too ready to give up. Commercial records are the result of a complicated and expensive process, and have been in the course of development for many years.

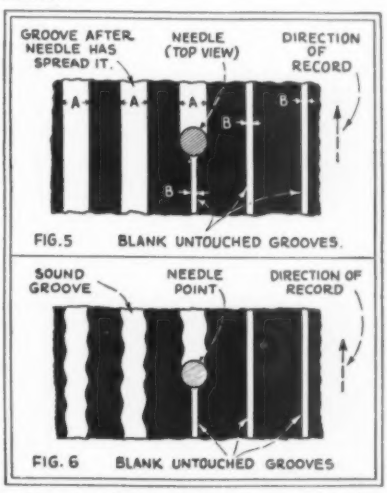
To say that the home recordist can make as good records as the commercial product would be going a bit too far; but it is a fact that home recordings can be made, and have been made, that compare very favorably with commercial records. The enjoyment and pleasure to be derived from real good home records justifies the care and patience expended in the effort.

What have you found out concerning recording; or what do you want to know about this interesting and lucrative field? Address your letters, enclosing a stamped return envelope, to the attention of the Sound Recording Department of RADIO-CRAFT.

ANOTHER SCOTCH STORY

IN Great Britain, as almost everywhere else, a owner of a radio set must pay a license fee for the privilege. And, so *Amateur Wireless* (London) tells us, "home-recording apparatus is having great sales in Aberdeen. By playing each programme twice instead of once through the loud-speaker the inhabitants of the Granite City feel that they are getting real money's worth for their license fee."

Aberdeen, be it known, is where the Scots are reputed (by their countrymen) to be canniest.



Above is indicated the manner in which the "pre-groove" is spread in the path of the needle; at the same time, the wall of the groove may be sound-impressed, as shown below.

Installing Radio in a Big Hotel

(Part II)

By ELI M. LURIE, B.E.E.

IN the last issue of RADIO-CRAFT a description of the radio and public address installation in the Hotel New Yorker, of which the writer is chief radio engineer, was followed by a discussion of the principles of designing similar equipment. The subject is resumed at the point where the problem of distortion enters.

It should be remembered that the required 40 watts of power per channel (of which there are four) must be 40 watts of *undistorted* audio output; which means that not more than 5% of the second harmonic component shall be introduced when operating at peak level.

If a single-tube stage of straight A.F. were used, then the tube would have to operate on the straight portion of its plate-current, grid-voltage characteristic curve (Fig. 3) in order to produce distortionless amplification. This condition is effected by so adjusting the plate and grid voltages that, when there is no externally-impressed voltage in the grid circuit, the operating point of the tube falls on the center of the straight portion of the curve, at A. If a symmetrical wave is now impressed on the grid, there will be symmetrical variations in the plate circuit; they will continue so, as long as the tube continues to operate on the straight portion of the curve.

However, as soon as the variations extend into the curved portions of the characteristic, at C and D, then the wave is slightly flattened on its peak points, and a small resulting *third harmonic* introduced into the output. This distortion, however, is comparatively small while the tube is operated with the center point of the curve as an axis, and is usually neglected.

As soon as either the grid bias or the plate voltage varies so that the tube operates from any other position (such as X, Fig. 3), then variations in the plate circuit will not be symmetrical with those in the grid circuit, and this will produce a double frequency or second harmonic in the output circuit. The greater the discrepancy between the positions of the center point of the characteristic and the actual working position of the tube, the greater will be the second harmonic. This finally results in strong overtones which completely alter the original modulation.

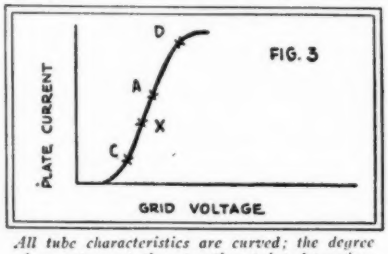
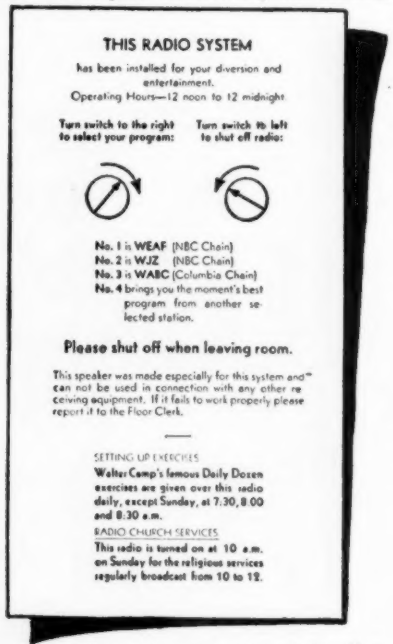


FIG. 3

All tube characteristics are curved; the degree of curvature at the operating point determines the degree of fidelity, in an audio circuit.

In the push-pull amplifier, this condition is to a large extent eliminated; for, in this type of amplifier, it is possible to operate the tubes at other positions on the plate-current, grid-voltage characteristic than the center point without introducing second-harmonic distortion. The reason is that, when a fundamental frequency is impressed, the two tubes of a push-pull amplifier operate 180° out of phase with one another. If this is the case, then a double frequency or second harmonic of the impressed fundamental must be 360° out of phase or, actually, in phase. If, now, the output windings are connected so that they buck one another, the fundamental frequency components will add and be passed on; while the second harmonic or double frequency term is cancelled and disappears. (The first of a series by Edgar Messing, entitled, "The Hows and Whys of the Push-Pull Circuit," appeared in the December, 1930 issue of RADIO-CRAFT.—*Tech. Ed.*)


THIS RADIO SYSTEM

has been installed for your diversion and entertainment.

Operating Hours—12 noon to 12 midnight

Turn switch to the right to select your program:

Turn switch to left to shut off radio:

No. 1 is WEAF (NBC Chain)
No. 2 is WJZ (NBC Chain)
No. 3 is WABC (Columbia Chain)
No. 4 brings you the moment's best program from another selected station.

Please shut off when leaving room.

This speaker was made especially for this system and can not be used in connection with any other receiving equipment. If it fails to work properly please report it to the Floor Clerk.

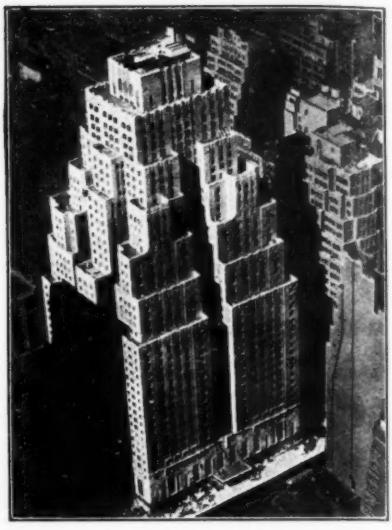
SETTING UP EXERCISES

Walter Camp's famous Daily Dozen exercises are given over this radio daily, except Sunday, at 7:30, 8:00 and 8:30 a.m.

RADIO CHURCH SERVICES

This radio is turned on at 10 a.m. on Sunday for the religious services regularly broadcast from 10 to 12.

The wall card in every room of the New Yorker; note the absence of volume control, since volume is regulated at the channel amplifier.


A bird's-eye view of the Hotel New Yorker, which towers over the Pennsylvania Terminal district of New York City. It is the city's largest and tallest hotel.

It should be remembered, however, that the cancellation of the double frequency or second harmonic is due to the fact that this distortion is generated in the push-pull amplifier itself, and is not passed into its grid circuit by the preceding amplifier. The push-pull amplifier does not distort or cancel out any of the *applied input*, but only that which is actually produced in the unit itself.

With the above factors in mind, we can proceed with the design of the amplifier to supply our load.

The Channel Amplifiers

Since our total load is to be 40 watts per channel, and we have decided to split this load into two 20-watt amplifiers, our separate amplifiers should be designed for this figure. The undistorted output of the '50 tube is rated at 4.65 watts when recommended maximum plate potential of 450 volts and a negative "C" bias of 84 volts is applied to the tube. This rating is increased by about 25% when the tube is used in a push-pull arrangement. Since each of our amplifiers is to be rated at 20 watts, it is evident that it will be necessary to use more than a single pair of '50's in push-pull; since their output is 11.6 watts, or a little more than half of the necessary value required. Therefore, if we put two '50's in parallel, on each side of our push-pull arrangement, our total output will be 23.25 watts. (The formula is: $P_{total} = (P_u \times N) + .25\ (P_u \times N)$, where P_u is the undistorted output of one tube, and N the number of tubes.)

As our output is to be only 20 watts, the extra amount is excellent as a safety factor. Thus a push-pull amplifier using the above arrangement should be satisfactory.

A question might arise as to why '50's should be used, when larger tubes such as the 211E (a 50-watt tube) would operate perfectly and carry the load with fewer tubes. The answer is obvious when one realizes that, not only is the cost approximately three times as great for this type

of tube, but also the 211E must be operated with nearly 1,000 volts on the plate in order to produce its rated output. To obtain 1,000 volts the rectifiers must also be of the high-voltage type; whereas, if '50's are used, only 534 volts is necessary, 450 for the plate voltage and 84 for the "C" bias. The '81 tube is ideal for this purpose and is very efficient.

The tubes used in the Hotel New Yorker have been in constant operation for over a year, operating a minimum of 12 hours per day (a total of almost 5,000 hours) and, at the present date, only three UX-250's have been put out of service. This speaks very well for this type of tube; but the UX-281's have given even better service, for the original tubes that were installed with the equipment are still in active service. On the contrary, the 211E tubes used in the public-address system have not given even a comparable service record, with reference to the '50's. To date our service from 211E tubes runs to about 400 hours.

Therefore, two '50 tubes in parallel on each side of our push-pull arrangement, with 540 volts supplied by '81 type rectifiers, should be ideal. Another problem that might cause questioning is with regard to the necessary number of '81's to be used. It is excellent policy to always use one '81 for each '50 used. On this basis, it is fairly easy to design a full-wave rectifier using two '81's in parallel on each side of the wave, giving us a total of four tubes; and this arrangement will carry without any trouble our load of about 150 milliamperes.

Automatic Plate Relays

In the rectifier circuit, it is important to incorporate a method of turning on the filaments of both the amplifier and the rectifier tubes *before* the plate voltage is applied. In the Hotel New Yorker's remote-controlled public-address system, this is taken care of by automatic plate relays which operate only after the filaments have been turned on for a period of about a minute. In the main or room-radio system, however, the interval is obtained by using special switches which, when placed in operation, must first be turned to position No. 1. In this position, A.C. line voltage is supplied only to the filament transformers; and then, when the switch is turned, to the second position, current is supplied to the plate transformers. In this manner, the tubes are given a chance to heat up before the plate voltage is actually applied. These switches are readily available.

The power transformer should have a minimum rating of 200 watts; and, if possible, a separate filament-heating transformer should be used.

The "C" bias for the amplifiers is obtained from a resistor which is incorporated in the power supply. The actual plate current is about 150 milliamperes; which means that (by Ohm's Law) the resistor should have a value of 560 ohms in order to produce a voltage drop of 84 volts for the grid bias.

Peak Voltage Readings

Many radio men have encountered the peculiar phenomenon of measuring the secondary voltage of a high-voltage plate transformer and then, after rectifying this voltage, finding the rectified voltage reading is either equal to or greater than the voltage measured right at the transformer.

The answer is that the reading obtained from the secondary winding with an A.C. voltmeter is not the *peak* value of the wave, but the *effective* value; which is only 70.7% of the peak value. The rectifier tube does not discriminate as the voltmeter does, but rectifies the actual applied or peak voltage. Therefore, if a transformer gives an output voltage *reading* of 600 volts, the actual peak voltage is $\frac{600}{.707} = 848$ volts. The transformer feeding an arrangement similar to the New Yorker's load should have an output effective voltage of about 600 volts on each side of the center tap. As figured above, the applied peak voltage is 848 volts per plate, but the transformer under load conditions will usually have a voltage drop. Also, the rectifier tubes and filter will add to this loss, so that the voltage on the plates of the amplifier tubes will be just about right. The values of the filter system are shown in Fig. 6.

Ahead of the push-pull amplifier, a good three-stage screen-grid R.F. amplifier and detector, working into a single stage of A.F. will produce enough energy to supply the load. In the Hotel New Yorker, four

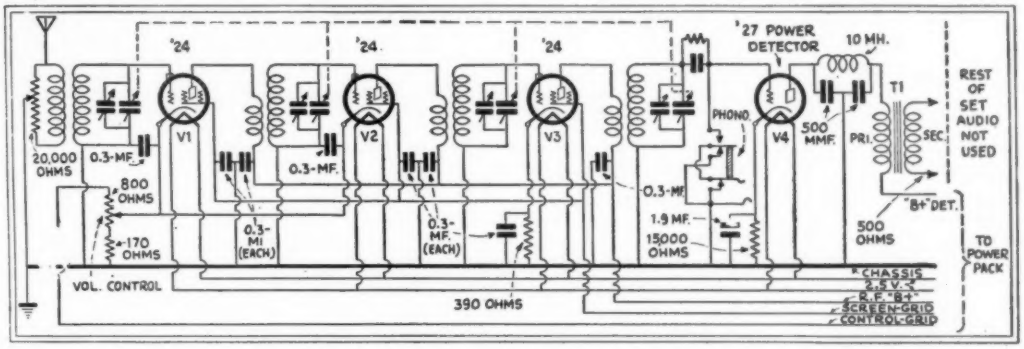


Fig. 4

Schematic circuit of the R.F. and detector of the Stromberg-Carlson "Model 641" used for guestroom radio service; there are four of these, while a fifth (illustrated last month in Figs. A and B) is provided with remote control for special services. The unit T1, a standard "tube-to-line" type, feeds the "booster" stage whose output goes to the channel amplifier.

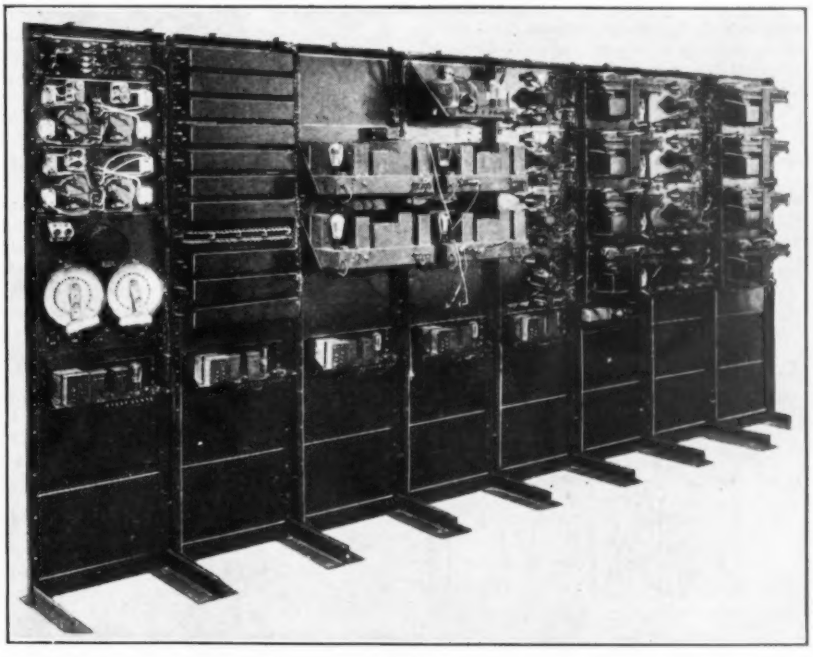


Fig. D

Rear view of the main radio control panel of the Hotel New Yorker; its front was shown as Fig. C in the June issue. The "booster" stages are the lowest row of units; the volume-level indicator is at the top of the fourth panel from the left. All wiring is cabled.

Stromberg-Carlson "Model 641" receivers are used. These receivers have been modified by removing their A.F. amplifiers; each detector feeds an external single stage of 227 A.F. which, in turn, feeds the two 20-watt push-pull amplifiers on that channel. (Fig. 5).)

Receiver Design

The schematic circuit of the "Model 641" is shown in Fig. 4. It should be observed that the output transformer is designed for a 500-ohm load. The reason for this value is that the remote-controlled public-address system is located on the fourth floor of the hotel, whereas, the main radio equipment is on the forty-first. Therefore, the transmission lines used for interconnecting the two systems cannot be operated at a high transmission-line impedance, because of the losses on the line which would be incurred when operating in this manner. Also, the output and input transformers of Western Electric equipment are usually designed for either 250-ohm or 500-ohm lines.

It is interesting to note that overloading of the detector, while possible, is extremely improbable. This most important device is operated as a "linear power" detector. That is when the input voltage increases, the plate current rises; which, in turn, increases the "C" bias by producing a greater voltage drop across the biasing resistor (a 15,000 ohm unit). (The grid leak and condenser in the detector's grid circuit are used, not for rectification, but to insulate the grid from the radio-frequency transformer when the phonograph pick-up is in use.)

The plate potential on the detector is 250 volts; and the plate current is about two milliamperes, which results in about 30 volts being applied to the grid as "C" bias. The detector is capable, therefore, of working at high radio-frequency voltages; and, by using the above system of automatic grid bias, the tube operates on a linear-variation basis, supplying audio output from radio input *linearly*, instead of *"square-law"* values, which the grid-rectification type of detector produces. Thus second-harmonic distortion, which is almost always inherent in the grid-rectification type detector, is quite absent from this unit. The reproduction from broadcast stations which have 100% modulation is noticeably improved in quality when using the linear-power detector.

The receiver was originally designed to use only a single (power) stage of A.F. However, because of the high gain needed in an installation the size of the New Yorker's, it is evident that the tube for this position should be of the "voltage-gain" type; especially so, when the final stage is a power stage.

A "Booster" Stage

To eliminate any possible chance of motorboating or feedback, the detector unit utilizes a separate power supply; so that, though the filament of the '27 in the first stage of A.F. receives voltage from the detector unit, the detector's plate voltage is supplied from the main rectifiers. The plate supply is dropped from the maximum of 540 volts, to 130 volts by means of a 66,000-ohm resistor. The resistor also acts as a filter to prevent possible interaction between the two amplifiers, due to the fact that both use the same plate supply.

The plate current of the '27 in the first stage of A.F. is about 6.2 milliamperes which, when used in conjunction with the 1500-ohm biasing resistor, results in 9.3 volts grid bias. Both the input and the output lines of all amplifiers are brought out to the main distribution panel, where they are connected to jacks. Thus it is possible to connect any amplifier or group of amplifiers, as the operator desires. An amplifier may be taken from any channel and transferred to any other channel by merely plugging "patching" or cross-connecting cords into the proper jacks. When all cords are removed from the panel, the line-up of amplifiers is numerical; that is, detector unit No. 1 feeds the primary amplifier No. 1 which, in turn, feeds the main amplifier rack No. 1, etc.

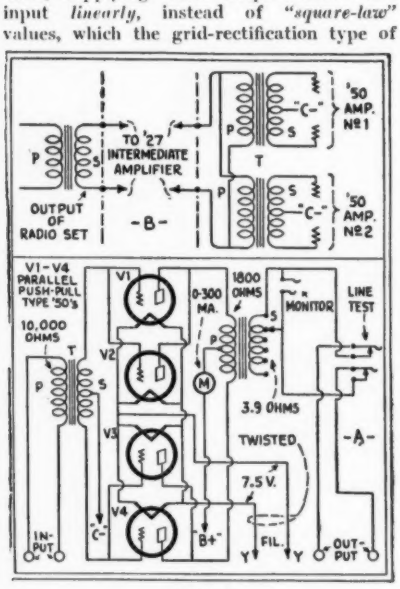


Fig. 5

Below, the connections of the push-pull amplifiers, using four '50s each; Nos. 1 and 2 are alike. Above, the method of feeding both amplifiers through a '27 "booster" stage (not detailed here).

Distribution of Load

Very little service work is necessary on this installation; since all the wiring is run down through the house in lead sheath, and branches, to various floors, from the lead sheath cables are run in iron conduit. *There are no exposed wires anywhere in the entire installation.*

The distribution of the load throughout the building is accomplished by means of fourteen "risers." Each riser is a lead-covered cable containing 26 pairs of No. 16 rubber covered wire. (See Fig. 2, in the preceding installment.) The hotel is divided into two sections, the north and south sides. Seven of the fourteen risers feed the north side and the other seven feed the south side. It is so arranged that any single pair feeds only thirty-two rooms. As each speaker takes 50 milliwatts, any single line, when loaded to capacity, carries only $50 \times 32 = 1600$ milliwatts, or 1.6 watts.

It is also arranged so that groups of eight rooms on the same floor that are in numerical order are all wired numerically. (See Fig. 1.) Then, from each of the eight rooms, lines are dropped to the same numbered room on the four floors below. Thus, if the feeder feeds rooms 1710 to 1718, then lines are dropped from each of the eight rooms directly down four floors; so that 1710 supplies 1610, 1510 and 1410; 1711 feeds 1611, 1511 and 1411, etc.

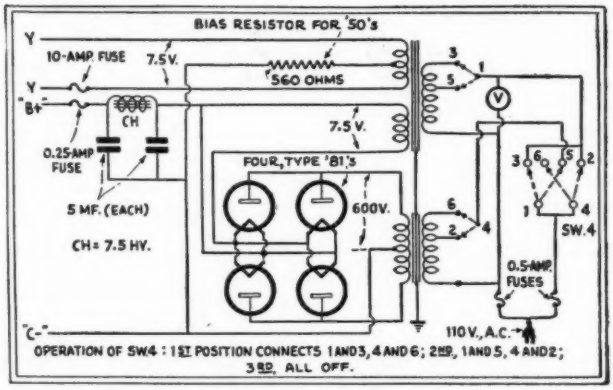


Fig. 6

The schematic circuit of the rectifier system used for powering each of the four-tube, type '50 channel amplifiers, such as shown in Fig. 5 below; the unusual filter constants will be noted. The switch Sw4 is provided, in order that the filaments of the '81s may be heated before the high plate voltage is applied. About a minute is permitted to elapse. The output is about 150 milliamps at 540 volts—"B" and "C" added.

Shooting Trouble

By this method, a defective switch or ground can be located by merely examining the radio equipment in the upper eight rooms. Trouble in any section of 32 rooms is very easily determined by means of either an ohmmeter or a "wire chief's" outfit. Once trouble has developed on any line, that line is cut out of the circuit by pushing a plug into a jack on the test board in the radio room. The line is then tested, and it is not put back into service until the trouble has been cleared. Cross-talk, the greatest "Jonah" of most large installations, is negligible in the New Yorker.

Radio Service Men should feel that there is a promising field in this type of work; since all of the men employed in the radio division of the New Yorker are Service Men and were all at one time actively engaged in radio service work.

There are many details in this installation that are out of the ordinary in that they are rarely heard of; yet almost everyone in the radio field would like to learn about them. For this reason, subsequent issues of RADIO-CRAFT will deal more fully with the apparatus about which complete details have not yet been furnished. At the same time, the writer extends an invitation to anyone interested in obtaining other data on this subject to write to him, in care of RADIO-CRAFT (enclosing a stamped return envelope). He would also like to receive photographs of other hotel radio installations.

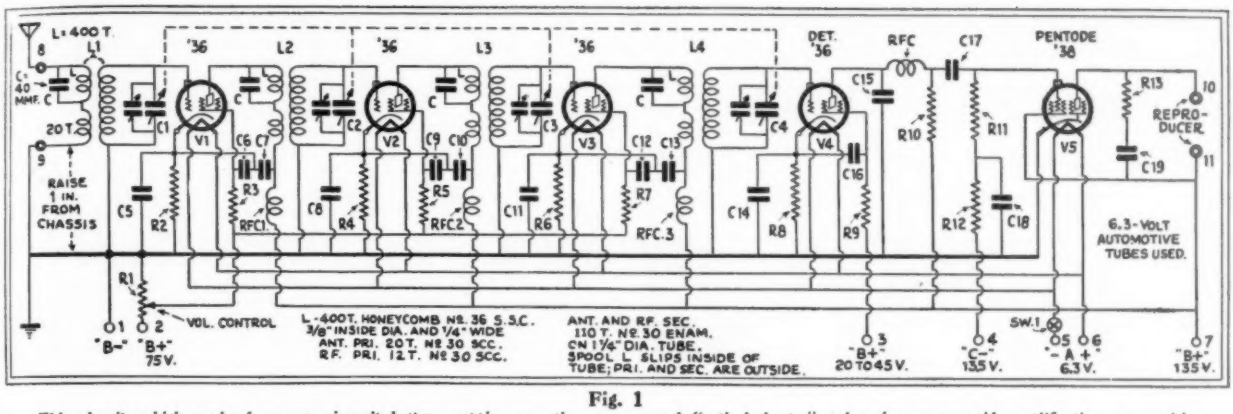


Fig. 1

This circuit, which works from any six-volt battery supply, uses the new, rugged "cathode-heater" tubes for screen-grid amplification, a sensitive detector, and an output pentode. The tone filter R13-C19 is adapted especially for the characteristics of the final tube and its average output load.

Building a Set for the Motor Car

Around the Latest Tubes

By C. E. DENTON

THE introduction of several new and improved tubes, designed especially for use in automobile radio receivers (as announced in the preceding issues of RADIO-CRAFT) is certain to give great impetus to this class of radio construction. As a matter of fact, it is no secret that practically all the tubes previously used have failed to function satisfactorily when applied to automotive work. The type '22 screen-grid tube is too fragile; this objection also applies to the 2-volt tubes. The '01A tubes lack the required sensitivity and gain. Other tubes used were unsuitable, because of their inability to function properly over the range of heater voltages encountered during the charge and discharge cycles of the automobile storage battery. In most automobile sets, microphonic disturbances and crackling sounds were the rule, rather than the exception.

All these troubles were due to the attempt to employ tubes which were primarily designed for other purposes, instead of being specifically made to operate under the exceptionally difficult conditions met with in automotive work. As a result, the initial keen interest in automobile radio sets waned, and failed to bring about the universal application of these receivers, so freely predicted several years ago.

Now, however, with the advent of the special automobile tubes, intense interest is again being manifested in the subject of automobile radio sets. The mere announcement of the tubes has resulted in a flood of requests for a suitable circuit in which to use them. In answer to this demand, such a circuit has been designed and is presented in this article.

Efficient Circuit Features

The five-tube receiver described takes advantage of every practical possibility offered by the new tubes, and hence this receiver will give results closely approximating the modern, well-designed home radio set.

The circuit consists of three tuned R.F. stages, employing the new type '36 screen-grid tubes; a screen-grid detector, also using a '36 tube; and a single audio output stage, using the new type '38 pentode tube.

Including the detector circuit, there are four tuned stages, all "ganged" and controlled by the movement of a single dial; the condensers are of the "battleship" shielded type. The screen-grid detector is of the grid-bias (power) type. For most sensitive detection with resistance coupling (between the detector and the audio stages) it is necessary to reduce the screen voltage on the detector tube to between 20 and 45 volts. The detector's "C" potential is obtained by automatic biasing, using a resistor R8 in the cathode circuit.

The antenna coupler L1 and the three R.F. coils L2, L3, L4, all shielded, are especially designed to give even amplification at all broadcast frequencies. In order to accomplish this desirable effect, an R.F. choke L is connected in series with the primary of each coil. The chokes L are tuned by small fixed condensers C of such a value as to resonate the former between 500 and 600 meters. The secondaries of the coils are tuned by the sections of the four-gang variable condenser. (The principle involved is described in the article "Design of R.F. Transformers," May, 1931, issue of RADIO-CRAFT.—*Tech. Ed.*)

The new C-336 screen-grid tubes used as R.F. amplifiers and detector, and the C-338 pentode, incorporate quick-heating, oxide-coated cathodes.

Because of the special cathode design, the heater's voltage may vary from 5.5 to 8.5, during the charge and discharge cycles of the automobile battery, without appreciably affecting the performance or serviceability of the tubes. Since these tubes have uniform heating over a wide range of heater voltage, no resistance is required in the heater circuit; which is to be operated from the "6-volt" automobile battery.

It will be noted from the illustrations that the receiver uses an aluminum chassis and that all parts are adequately shielded. Stable operation of the '36 type tube, in R.F. circuits designed to give maximum gain per stage, requires separation of the input and output circuit elements. In a high-gain multi-stage R.F. circuit, such as the one employed here, *it is necessary to use complete stage shielding in order to realize the amplification possibilities of the '36 tube.*

Referring to the schematic circuit diagram (Fig. 4) it will be seen that the various plate and screen-grid circuits are carefully isolated by resistors or R.F. chokes, all of which are suitably by-passed to ground by small by-pass condensers. This is necessary to prevent interaction between the various portions of the circuit.

The potentiometer R1 serves the double purpose of providing adequate screen voltage regulation and also of controlling the volume. The R.F. choke RFC, by-passed by the .001-mf. fixed condenser C15, keeps the R.F. currents out of the audio portion of the circuit.

High Amplification of Pentode

As mentioned above, only one audio stage is necessary when using the new '38 pentode; this is a screen-grid tube designed for the special purpose of giving large audio output with relatively small signal voltages impressed on the grid. This result is made possible by the addition of a "suppressor" grid, located between the screen and the plate, and connected *inside the tube* to the cathode as indicated in the schematic diagram; therefore it is operated at the same potential as the cathode. As a result of this construction, the suppressor eliminates practically all of the "secondary-emission" effects which limit the power output from four-electrode screen-grid tubes.

The pentode is capable of producing much greater power output than three-electrode power amplifiers of the same plate dissipation; in addition, the pentode has a much higher gain than could be obtained from the three-electrode amplifiers without

great loss in power output. The actual figures, showing the important characteristics of the type '38 tube, are illuminating. It has an amplification factor of 100, a mutual conductance of 900 micromhos, and an undistorted power output of 375 milliwatts.

In order to utilize the pentode to its best advantage, the impedance of the speaker winding should be close to 15,000 ohms; this value has been selected in order to limit the second-harmonic distortion to a minimum. (Because of the audio output load characteristics, which rise with frequency, a tone-compensation circuit is followed; this includes R13 and C19.—*Tech. Ed.*)

Constructional Notes

A sheet of No. 12 gauge aluminum is bent on all four sides to form a chassis 16" x 7" x 3" high, as shown. The five socket holes are drilled and the sockets are mounted; then the four-gang condenser is turned upside down and the four R.F. coils are mounted on the side wall underneath the tuning condensers. All other parts (except the resistors of pigtail type) including fixed condensers, R.F. chokes, potentiometer R1, etc., are mounted as indicated in the bottom view of the receiver, Fig. 2C. The chassis is then turned right side up and the four binding posts are mounted. (These must be very carefully insulated from the chassis.)

The set is now ready for wiring. The filament circuit is wired in first (one side of the battery is automatically grounded by the car wiring). The switch SW is wired in on the end of a two-wire cable, long enough to reach from the place where the set is to be mounted, to the control panel on the dash. The grid circuits are then wired in; the connections which go the caps of the type '36 tubes are clearly shown on the diagram. The 135-volt grid connection on the pentode goes to the socket terminal marked "G"; in fact, all screen-grid connections are made *at the sockets* in the regular way. Plate circuits are wired in next; then cathodes, by-pass condensers, negative returns, antenna circuit, volume control, etc.

All resistors except R1 have for clarity been omitted from the bottom view, Fig. 2C. They are held in place by soldering them to their respective terminals during the process of wiring, as follows: R2, cathode of V1 and ground (chassis); R3, screen-grid terminal of V1; R4, cathode of V2 and ground; R5, screen-grid terminal of V2; R6, cathode of V3 and ground; R7, screen-grid terminal of V3; R8, cathode of V4 and ground; R9, screen-grid terminal of V4; R10, soldered to RFC; R11, to C17; R12, to R11 and C18; R13, binding post No. 10 and C19.

After these resistors are soldered in place, and all other wiring is finished, the battery cable should be fastened in position. Extreme care should be taken to prevent possible short-circuits later in the leads brought up through the chassis deck. Most of the wiring will be on the underside of the deck; and should be short and direct. "Solid core" wire will be found most convenient to work with.

After the wiring has been completed, and the shields have been fastened over the R.F. coils, each individual circuit should be checked over and traced out carefully. If different colored wires have been used for grid circuit, plate circuit, etc., this checkback will be greatly simplified.

The receiver is now connected to a 20-foot aerial, approximating that to be used in the car. Batteries and loud speaker are

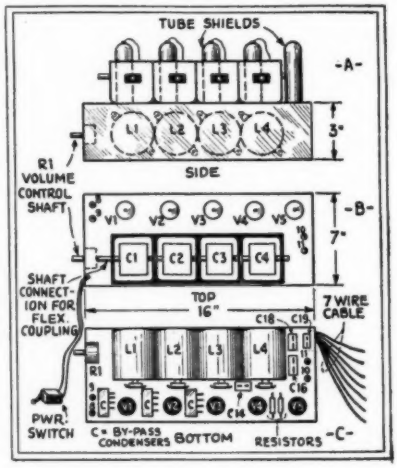


Fig. 2

Three views showing the layout of apparatus which is most compact for this automotive set. The shielded R.F. transformers are mounted horizontally, with their small resonating condensers C in front

then connected. The only adjustment indicated is that of the four trimmer condensers on the four-gang variable condenser.

The receiver now should operate perfectly; however, the voltages should be first accurately checked with a *high-resistance* voltmeter.

The arrangement of the parts on the chassis is such that the receiver may be mounted below the dash of the car at any convenient out-of-the way point; with its volume and tuning controlled by means of flexible shafts (similar to speedometer shafting). Details as to the mounting of an automotive receiver: including the problems of the car aerial; placement of "B" batteries; flexible shafting; dash controls; modification of "A" connection for "grounded positive" or "grounded negative" storage-battery leads; and methods of interference elimination have been the subjects of extensive articles in past issues of RADIO-CRAFT. (A list of these issues, by dates, is as follows: Dec., 1929; Jan., Feb., Mar., May, June, July, Aug., Sept., Oct., Nov., Dec., 1930; April, 1931.—*Tech. Ed.*)

List of Parts

One Hammarlund "battleship" type 4-gang, .00035-mf. variable condenser, C1, C2, C3, C4;
Nine Polymet 0.1-mf. rectangular-type by-pass condensers, C5, C6, C7, C8, C9, C10, C11, C12, C13;
Three Polymet 1-mf. 200-volt rectangular-type condensers, C14, C16, C18;
One Polymet .001-mf. mica fixed condenser, C15;
Two Polymet .01-mf. mica fixed condensers, C17, C19;
One Electrad "Tonatrol" 50,000-ohm potentiometer, R1;
Three Electrad 400-ohm flexible, wire grid resistors, R2, R4, R6;
Four Durham 50,000-ohm "metallized" 1-watt resistors, R3, R5, R7, R12;
Two Durham 10,000-ohm "metallized" 1-watt resistors, R8, R13;
One Durham 100,000-ohm "metallized" 1-watt resistor, R9;
Two Durham 250,000-ohm "metallized" 1-watt resistors, R10, R11;
One 7-wire cable, 1, 2, 3, 4, 5, 6, 7;
Four Type X-L binding posts (antenna, ground, and output), 8, 9, 10, 11;
Four shielded R.F. transformers for .00035-mf. tuning condensers, L1 antenna, L2, L3, L4 radio-frequency;
Four Polymet .00004-mf. mica fixed condensers, C, for the primaries of the R.F. transformers.
Four 85-mh. R.F. chokes, RFC, 1, 2, 3;
One power-type toggle filament switch, Sw;
Five screen-grid clips;
Five aluminum tube shields;
Five UY-type sockets;
Four Cunningham Type C-336 6.3-volt screen-grid tubes, V1, V2, V3, V4;
One Cunningham Type C-338 6.3-volt pentode tube, V5;
One aluminum sheet, 12-gauge, 22 x 13 in.;
Hook-up wire, etc.
Speedometer cable, of the required length, to be used for operating the variable condenser gang and the volume control from the car's instrument panel, or other position. This may be obtained from automotive service stations. Adjustments must be made for smooth operation.

NEW RADIO SYMBOLS

THE progress of the art of radio is continually enriching us with new devices; and, of course, the symbolism which is the shorthand of radio must enlarge its gallery.

Some few symbols, it is true, might be cleared away, like the dishes of the last dinner course when the next is brought on.

Especially are the new tubes which have appeared during the past few weeks a challenge to the ingenuity of the radio artist. Here, for instance, we have one which has been suggested by Mr. J. Geartner, of the Arcturus Radio Tube Co., for a new product which is intriguing the industry just now.

We shall offer no prize for the solution of this rebus, which represents a seven-letter word. But we invite readers who have other suggestions for new radio symbols and illustrations of radio terms to send them in for appropriate illustration. (It may as well be stated, here and now, that variations on the hackneyed theme of "Ohm, Sweet Ohm" are barred in advance.) But what have you?

A Short-Wave Receiver-Adapter

For independent use or as a permanent addition to a broadcast receiver

By L. MITCHELL BARCUS

UNLIKE other short-wave adapters, that which the writer has constructed becomes an integral part of his broadcast receiver, giving instant choice of short or long waves, by operation of its built-in switch. It may, however, be attached or removed in but a few minutes. Aside from its use as an adapter, it is not, as might be supposed, practically useless. Without changes of any sort, it serves as a complete receiver, using either an eliminator or "B" batteries for the plate voltage. By getting the "B" potential from the last R.F. stage of the broadcast receiver (which has a tendency to throw the latter into oscillation) and tuning the broadcast receiver to some broadcast station on the lower portion of the dial, harmonics may be easily picked up down to 10 meters or lower. This method is invaluable in calibrating wavemeters and oscillators.

Because it was designed for use with the dynamic speaker, the tuner is followed by three audio stages, when used with most sets. Although this is unsatisfactory (and entirely unnecessary), with head phones it has been found that it enables the most distant stations to be clearly received on the speaker. And, when the tuner is attached to even a fair receiver, hum and mechanical noises are almost completely wanting. In addition, the use of three stages permits the filtering out of the high-frequency static by use of a suitable tone control; thus providing more enjoyable reception without seriously cutting down on the volume of the signals. A 250,000-ohm variable resistor and an .006-mf. condenser, shunted in series across the secondary of the set's first audio transformer, make a very satisfactory combination for this purpose.

Although the tuner is shown as used with a modern A.C. broadcast receiver having two audio stages, the constructor must realize that its usefulness is by no means so limited. It may be used with any receiver, by increasing insufficient "B" voltages with one or two "B" batteries, or cutting down anything over 180 volts with a suitable resistor. In districts where A.C. supply is not available, the three filaments may be wired in series, omitting the center-tap resistor, and used in conjunction with a suitable battery. The new tubes available give a wider choice of amplifiers than hitherto available.

Construction of the Tuner

The layout diagrammed (lower left) was chosen because it permits more direct leads; which is of utmost importance in an instrument of this kind. The R.F. and detector stages being side by side, the shortness of the lead between the two eliminates both the need of a shielded wire at this point, and the capacity between the wire and its metal covering. The condensers and resistors not shown are mounted beneath the subpanel, taking great care to have them as near their associated coils or tubes as possible.

The separate filament transformer used here is placed several feet away, to lessen any chance of inductive hum and simplify one of the problems of A.C. operation. An individual switch for this transformer allows the tubes to warm up while the broadcast receiver is operating; this may be of any type satisfactory to the constructor. All filament leads and wiring are of shielded cable and grounded.

To facilitate changing coils, the constructor may find it a good plan to mount the lids of the aluminum shields on the underside of the cabinet's lid. The subpanel should be raised enough to assure that the lid rests firmly on the shield; if this is unhandy, the metal lid may be lowered by a thickness of wood.

Because it is difficult to specify definite components which are readily obtainable in any locality, the details of the socket-plug needed are left to the constructor; the only requirement being to separate the plate prong of the detector tube from the plate of its socket, and to bring out a lead from each. For this purpose an old tube base and a socket (UX or UY as needed) may be bolted together; connecting the other prongs to the socket with short lengths of wire.

Operation

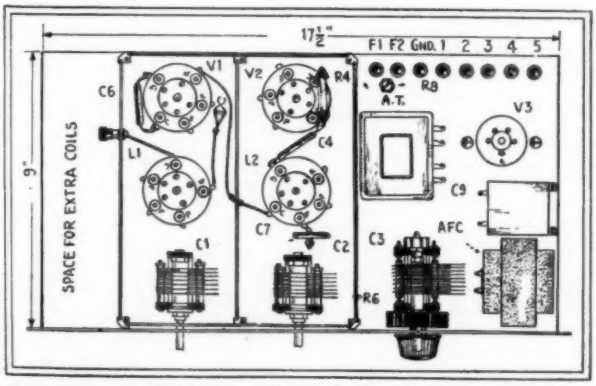
To attach the tuner to the broadcast receiver, only a few simple connections are required. The two leads from the socket-plug are soldered to two of the wires of a four-wire cable. The socket-plug is then placed in the detector tube socket of the broadcast set, and the tube is replaced in the socket of the adapter plug. On the end of another of the wires a small loop, which will fit tightly over a tube prong, is made and soldered. This is the tap to the plate of the audio tube. The remaining cable lead goes to the ground of the set; if quick changing is desired, a small test clip may be fastened to this lead.

The cable is then connected to the proper binding posts of the tuner; the antenna is connected; the filament supply is switched on; and the builder sits down to enjoy some of the true marvels of short-wave reception.

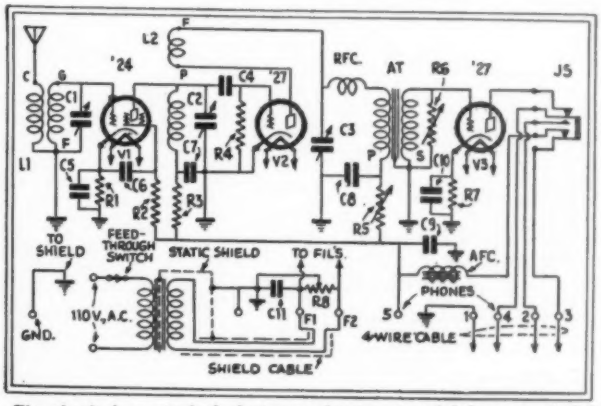
If the tuner is placed on top of the broadcast receiver, it may sometimes set up a very objectionable hum, due to interaction with the power transformer of the set. In this case it is necessary to turn the tuner at right angles, or remove it a few feet away.

For best results with any short-wave receiver, it should be placed as close to the antenna lead-in as possible, for the losses incident to long, straggling leads mount up rather terrifyingly when dealing with the higher frequencies. It is not at all necessary to provide another aerial for this tuner, if the broadcast antenna is of first class construction with as few turns or sharp

(*Continued on page 51*)



Above, the layout of the tuner as it was built by the author; the filament transformer is placed elsewhere. Attaching the shield covers to the cabinet's lid makes changing coils easier. The unit may be connected to the broadcast set by a plug, as shown, or by a built-in switch.



The circuit is a standard short-wave detector, preceded by a tuned R.F. screen-grid stage, and followed by an A.F. stage to obviate troubles which might follow its connection directly ahead of the set's A.F. amplifier.

Improving Short-Wave Reception

A discussion of the special features governing short-wave receivers, with constructional hints

By CLYDE A. RANDON

EVERYONE with any experience whatsoever with short-wave receivers (operating below 200 meters) is aware of the fact that seldom are they very sensitive; in the use of short-wave adapters, particularly, very mediocre results have been obtained. This has caused dissatisfaction to many users of short-wave sets. If the sensitivity of the average short-wave receiver could be radically improved, many users would find a new satisfaction in tuning in foreign stations.

The causes of this relatively poor sensitivity, although perhaps apparent to the short-wave specialist, are less obvious to the average short-wave experimenter. It is, of course, useless to discuss the causes of insensitivity in such sets without giving practical remedies; this article will discuss also the practical application of methods for improving the sensitivity of the average short-wave receiver or adapter.

Since ordinary "broadcast" receiving sets (operating between 200 and 550 meters) are more or less familiar to the reader, a comparison will be drawn between them and "short-wave" receivers. The most important contrast and, of course, the most obvious, is the difference in frequency between ordinary broadcasting and short-wave signals. High-frequency phenomena cause all our troubles.

Within the R.F. coils there are eddy-current losses, ordinary resistance losses, and dielectric losses; in general, all these are greater at higher frequencies. There is, however, a counteracting effect: the number of turns used in the coils for short waves is less; so that the resistance due to the wire itself (the "copper" loss) is reduced. However, the eddy-current and skin-effect losses are increased.

Use Ample Shielding

As at broadcast frequencies, shielding is also used in short-wave receivers. Shielding always causes losses, to some extent; an effect which is quite pronounced at the higher frequencies. A shield should be larger for short waves, than long waves, considering coils of equal size; nevertheless, the same shield sizes are, in general, used with the result that the losses are considerable. (See Fig. 1.)

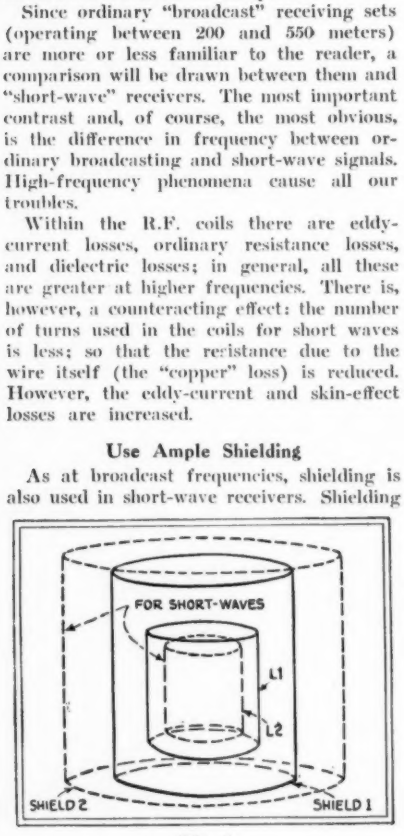


Fig. 1

The big long-wave coils may have shields much closer than is practical with short-wave coils, which are more sensitive to metal in their fields.

In general, the diameters of short-wave coils have been too large; therefore, their fields have also been large, resulting in high losses. The trend in present design is toward coils having smaller dimensions, with shields giving more "breathing" room to the coils they contain.

Choke coils, also, are not as effective in short-wave receivers as they are in broadcast work. The difference in effectiveness is partly due to the fact that the ordinary short-wave R.F. choke must be operated over a great frequency-range. If the range to be covered were limited, very efficient choke coils could be designed for the conditions. But this is not the case; so that the usual choke coil is more effective at some particular frequencies. (The "by-pass effect" in R.F. chokes is illustrated in Fig. 2.) The usual choke coils are not as effective at very high frequencies as at the lower.

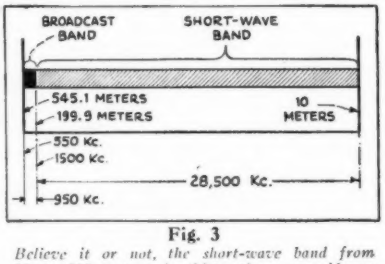


Fig. 3

Believe it or not, the short-wave band from 10 to 200 meters is thirty times as wide as the 200-545-meter broadcast band.

Then, too, the ratio of inductance to capacity, (the L/C ratio) undergoes such a large change in tuning over the enormous frequency-ranges used in short-wave receivers, that the usual short-wave tuned circuit must have a set of about three inductance coils. By means of the three coils, and this condenser (usually of the "midget" type), the entire range from ten to perhaps one hundred meters is covered; a very wide frequency-band. (See Fig. 3.)

The ratio of inductance to capacity, in the tuned circuits of an R.F. amplifier stage, has considerable effect on the total gain of the amplifier. If a large value of inductance is used, the amplification is greater than if a large value of capacity is used, at the same frequency. Thus, it is evident that, were all other factors the same, the amplification of short-wave radio frequency amplifiers would be considerably less.

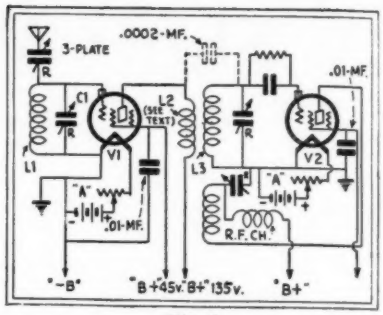


Fig. 9

Methods of coupling a tuned screen-grid stage to a short-wave detector. L2 is a short-wave R.F. choke.

However, there are other contributing factors which lessen the amplification; so that the total amplification obtained from an R.F. stage operating at short-wave lengths is considerably less than that obtained at broadcast frequencies. (See Fig. 4.)

Great Frequency-Range

It will be recalled that the tuning capacity in a broadcast receiver may be between .0003- and .0005-mf., with a shunt "trimmer" of perhaps 20 to 75 mmf. The short-wave job seldom requires a trimmer (a requisite for ganging tuned stages). In fact, the *tuning* capacity often has a maximum value of 75 mmf., and seldom do builders use capacities of .0003-mf. The smaller tuning condensers used in short-wave receivers "spread" the dial tuning (bear this in mind, if you find that short-wave stations whip in and out "like lightning.") Remember also that, on the basis of 10-kc. separation between stations, there are only 96 10-kc. "channels" in the broadcast frequency range, 550 to 1500 kc.; while in the short-wave spectrum from 1500 kc. (200 meters) to 30,000 kc. (10 meters), there are 2,850 10-kc. channels. (Fig. 3.)

Another striking difference between short-wave sets and ordinary broadcast receiving sets, lies in the relative values of the tuning condensers and grid condensers, and the capacities within the tubes of the set.

By-pass condensers across resistors, and voltage leads, in short-wave sets, often have the low value of .01-mf.; while a condenser in the same position in a broadcast set might need to be 2-mf. or more.

At broadcast frequencies (since the advent of the screen-grid tube, at least) the grid-to-plate capacity has been made negligible. However, this capacity has not been entirely eliminated; so that at very high frequencies the effect of even the smallest

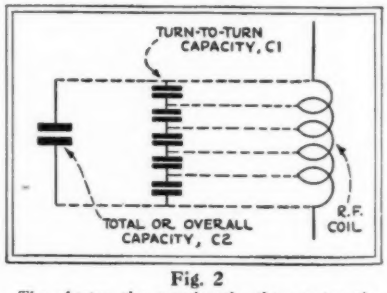


Fig. 2

The shorter the wavelength, the greater the effect of inter-turn capacities to lessen the voltage across the coil.

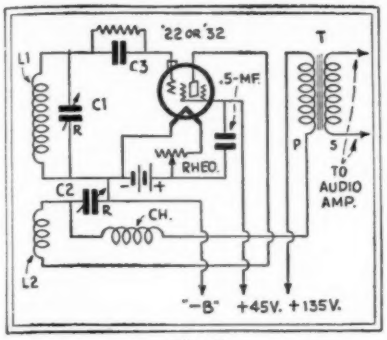


Fig. 7

The screen-grid detector, the value of which is recognized on long waves, is (comparatively) more efficient for short waves.

capacity again enters. An outstanding failing of the screen-grid tube at high frequencies is its large screen-to-plate capacity which causes a loss within the tube, so to speak, from plate to ground.

Such internal losses are especially evident in short-wave oscillators which will not "perk" at the very high frequencies. The introduction of losses necessitates increasing the feedback, and a point may be reached where the feedback, under existing circuit conditions, can not be increased farther; then the tube refuses to oscillate.

Losses in Five-Meter Receivers

If the increase in frequency materially decreases the sensitivity of short-wave receivers, one would naturally expect an ultra-high frequency receiver to become very insensitive, indeed. This has been found the case, by the writer and a few other experimenters in this most interesting short-wave field. Sixty thousand kilocycles is a very high frequency, indeed, corresponding to a wave length of five meters. Here the tuning condensers must be so small that the tube capacities approach them in magnitude; in fact, half the tuning capacity, so to speak, is often within the tube itself. Exaggerated conditions like these, show, in a very striking manner, the effect of increasing the frequency to be received by a short-wave receiver.

In Fig. 5, the essential connections for an ordinary short-wave receiver are shown. A small choke coil Ch is connected either at the point X or the point Y in the diagram.

In most well-designed sets, the choke coil is connected at the point Y; because at this point it is most effective.

Coil L1, connected in parallel with C1, is the tuned circuit of this detector outfit. Coil L2 is the tickler winding, used to furnish regeneration and thus greatly increase

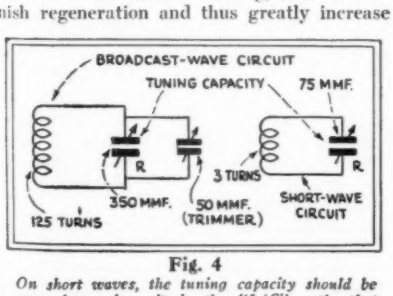


Fig. 4

On short waves, the tuning capacity should be very low; since it is the "L/C" ratio that governs the impressed signal voltage.

the signal amplification as well as the selectivity of the tuned circuit.

Regeneration could also be used in an R.F. amplifier to increase the amplification; but the tuning range is normally so great that an extra control would be necessitated.

The very intimate relations of the tuned circuit to the capacities within the tube itself are shown in Fig. 6. Evidently, the relative values of the tube capacities compared with the tuning condenser must have a considerable effect on the operation of the circuit.

The size of the detector grid condenser GC is quite important, because the entire parallel arrangement of condensers is coupled to the tuning circuit through the grid condenser. Therefore, a small value of grid condenser is desirable at short-wave lengths; in fact, a .0001- or .00015-mf. value is normally used. (At broadcast wave lengths, the grid condenser is generally .00025-mf.)

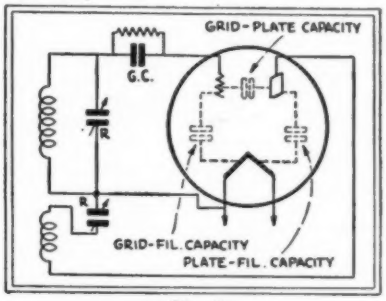


Fig. 6

The tube capacities, input and output, as well as the grid-plate feedback capacity, determine finally the efficiency of a circuit.

"Numerical Sensitivity"

Another difference between an ordinary short-wave set and a broadcast set is in the number of stages of radio-frequency amplification that are used. Perhaps the foremost reason why short-wave receivers do not use more stages of radio-frequency

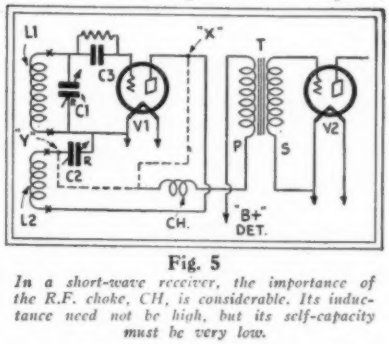


Fig. 5

In a short-wave receiver, the importance of the R.F. choke, CH, is considerable. Its inductance need not be high, but its self-capacity must be very low.

amplification for "numerical sensitivity," (that is, to increase the product of multiplying the figures of gain in the several stages) is the difficulty of operating with a single control all the condensers of the various tuned stages. The effects of distributed small capacities, differences in wiring arrangement, etc., make it difficult to line up the tuned circuits of the various stages. In view of the fact that the amplification of short waves is less, and the number of stages ordinarily employed also is less, it is obvious that the sensitivity of

(*Continued on page 53*)

How to Figure the R.F. Coil Secondary

(*With Tables of Coil Constants*)

By CLIFFORD E. DENTON

THE procedure to be followed in determining the inductance to be used with a given condenser, to cover a given range of frequencies, is a "closed book" to all too many radio workers. It is the purpose of this little article to shed some light on the subject; and the writer, after an effort to simplify the problem to the *N*th degree, hopes that the explanation will not be found too sketchy. However, if this article raises any questions in the minds of RADIO-CRAFT's readers, comprehensive consideration of every angle will be found in that famous sixty-cent textbook of the Bureau of Standards, "Circular No. 74."

(The article, "Design of Radio-Frequency Transformers," by Sylvan Harris, in the May, 1931, issue of RADIO-CRAFT may well be consulted for valuable data on the design of the primary of modern R.F. transformers.)

It is generally known that a capacity and an inductance form a resonant circuit; that is, the combination of a coil (inductance) and a condenser (capacity) will tune to a particular frequency or wavelength, and, by changing the electrical value of one unit or the other, the wavelength to which the combination will tune will be changed. But, if the electrical value of one unit is *increased*, while that of the other is proportionately *reduced*, it is possible to maintain resonance at the same frequency; that is, keep tuned to the same station. In other words, we have altered only the *ratio* between the electrical value of the coil and condenser—we have "changed the L/C ratio," to use a common expression. But the "L×C *product*" remains the same.

It is customary to vary the capacity of a condenser, to tune in stations; consequently if knowing the capacity in use, we apply the "L×C product" figure indicated for a particular wavelength (Table I) we immediately learn the coil value *required*. We are then in a position to go ahead and design this inductance. This table is extremely convenient for coil calculations and for that matter, in capacity calculations, too.

Calculation of Tuning Range

The values of inductance and capacity employed at radio frequencies are smal , and generally stated in microhenries of inductance and microfarads of capacity, as in Table I. The relation between the product (of the inductance and the capacity) and the frequency is given by the following formula:

$$f = \frac{159,200}{\sqrt{L \times C}}$$

In which f is expressed in cycles, L in microhenries, and C in microfarads. The table covers the broadcast band.

(*Continued on page 54*)

The Whole Ohm Family —R, X and Z

(Part II)

A Simple Explanation of Reactance and Impedance

By HAL WYMAN

Capacitative Reactance

The familiar phenomenon of the charge and discharge of a condenser, under direct-current conditions, gives rise to a complex effect in A.C. circuits. Just what this effect may be is readily understood by a review of the basic relations. A capacity differs from an inductance, not only in its physical constitution, but in the manner in which it is operative.

We saw that an inductance gives a back E.M.F. in direct proportion to the current through it. A condenser is rated in *farads* according to the quantity of electricity which may be added to the charge by raising the voltage across it by one volt; that is, a condenser which holds one coulomb (or ampere-second) of electricity for every volt across it has a capacity of one farad. This unit is so large that we employ the *micro*-farad in most ordinary calculations.

While an inductance opposes any change in *current* by producing a back E.M.F., a condenser opposes any change in the *voltage* across it by charging while the potential rises, and discharging as it falls off. That is, there arises a current opposing any voltage change. If we plot (as in Fig. 4) the current and voltage relations in a capacitative circuit, we will find that the current is at a maximum when the voltage change is greatest; this condition arises as the voltage curve crosses the zero line. We can see that the current is leading the voltage by 90 degrees; exactly the opposite of the condition in the inductive circuit whose characteristic is shown in Fig. 3.

By a process of mathematical reasoning, similar to that in the case of inductive reactance, we shall find that (when, as before f is the frequency in cycles, C the capacity in farads, E the impressed A.C. voltage, and I the back current which it causes):

$$I = 2\pi \times f \times C \times E$$

We therefore shall find that, while the inductive reactance *increases* with the frequency of alternations, the capacitative reactance *decreases* with the frequency. The statement of Ohm's Law, however, takes the same form:

$$E = I \times Xc;\ I = E/Xc;\ Xc = E/I$$

Hence: to find inductive reactance, multiply the inductance in henries by the frequency in cycles, times 6.283: the result is in ohms.

To find capacitative reactance, multiply the capacity in farads by the frequency in cycles, times 6.283; and divide 1.0 by the product: the result is in ohms.

(Note: since all capacities actually used are small fractions of a farad, this rule is not very convenient. It is better to use a capacity stated in microfarads and divide 1,000,000 by the final product.)

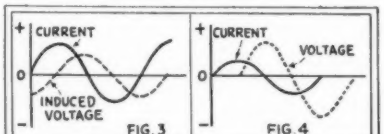


FIG. 3

FIG. 4

In inductive circuits, left, the current is considered to be behind the voltage in phase; in capacitative circuits, to be ahead of it.

We have also noted that inductive reactance in the circuit caused the current to lag; whereas capacitative reactance caused the current to lead. (We assume a purity of either inductive or capacitative reactance in the circuit when we specify a lead or lag of 90 degrees; if the circuit is not purely inductive or capacitative the reactance of the circuit as a whole is *"complex."*) In a simple series circuit of inductance and capacitance, the capacitative reactance is subtractive from the inductive reactance.

For example: In a circuit having across it an inductance of 1.5 henries in series with a 40-microfarad (.0004-farad) condenser, what is the total reactance to 60 cycles A.C.?

$$XL = 6.28 \times 60 \times 1.5 = 565 \text{ ohms}$$

$$XC = 1.0 \div 6.283 \times 60 \times .0004 = 66.3 \text{ ohms}$$

$$X = XL - XC = 498.7 \text{ ohms}$$

Had a pure resistance of 10 ohms been in series with the combination, this would also increase it; but the total impedance would not be exactly 508.7 ohms, but would have to be determined by a more complex formula.

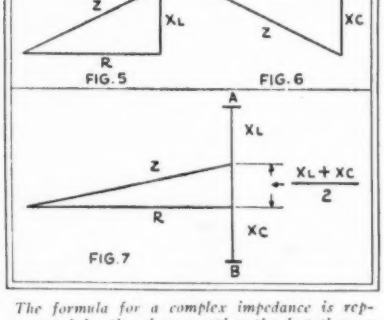


FIG. 5 FIG. 6 FIG. 7

The formula for a complex impedance is represented by the above graphs; the hypothenuse Z is the impedance. Remember that the sum of XL and XC is algebraic; *that is, they are in opposite senses, and one cancels the other.*

Computing the Impedance

In a circuit containing resistance alone, the current and voltage are in phase; in a combination of resistance and reactance, the impedance may be determined graphically by the construction of a right-angled triangle. (You may remember that, according to a famous geometrical theorem, the "square on the hypotenuse of a right-angled triangle is equal to the sum of the squares on the other two sides.") Our formula is:

$$Z^2 = R^2 + X^2$$

Then, as in Fig. 5, we can construct a triangle with R as the base, and XL the altitude; and measure the hypotenuse to find the value of the resulting impedance.

In the case of a capacity and a resistance, the triangle is constructed in a different manner with the altitude extended in the opposite direction as shown in Fig. 6. This leads us to a simple solution of the complex problem of inductance, capacitance and resistance in A.C. formulas.

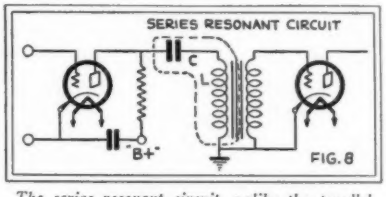


FIG. 8

The series resonant circuit, unlike the parallel, affords no path for direct current; but the resonant voltage developed is limited only by its losses (resistance).

As shown in Fig. 7, we first lay off the resistance; then the inductive reactance; then the capacitative reactance. The altitude of our triangle is then found by dividing the distance A-B by two; and the hypotenuse or impedance line may be drawn and measured.

This gives us a simple solution of the formula for finding impedance, which is:

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Alternating currents are amenable to Ohm's law in the same sense as direct currents—the fundamental relation being $I = E/Z$. It is necessary however, in considering *complex* circuits, to consider the *phase relations* of the currents in the different branches before a solution may be achieved. We must therefore resort to algebraic equations or graphs in order to obtain solutions.

Resonant Circuits

We have shown that a *series circuit* composed of resistance and reactance has an impedance equal, not to their arithmetical sum, but to their "vector" sum instead, because of complex phase relations in the circuit. The *current* through a series circuit is of course the same in each element; but the *voltage* (across each element) is determined by the resistance, impedance or reactance of the individual element. It is therefore possible for the voltage across any one element to be greater than that across the combination.

In *series resonant* circuits (by "resonance" we describe the condition in which, at some one given frequency, the capacitative and inductive reactances are equal) we find a

(*Continued on page* 56)

Letters from Radio CRAFTSMEN

We all like to hear what the other fellow has been doing: and he would like to hear what you have done. C'mon in, Craftsmen!

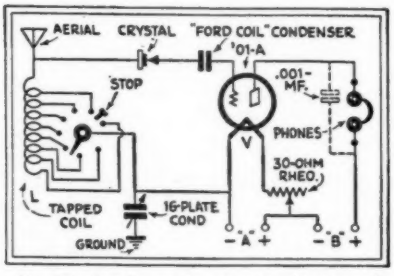
TING-A-LING-LING!

Editor, RADIO-CRAFT:

Mr. Sprayberry's article in the May issue, on adapting the Radiola "28" to two-volt tubes, was well received by the writer, as well as by six other readers in this city. I am anxiously waiting the publication of the next by the same author on the "25" and the "AR-812." Can't be too soon. RADIO-CRAFT rings the bell.

BERNARD M. MUEHR,
1316 *Farnum St., LaCrosse, Wis.*

(Mr. Sprayberry, who has been working on these sets, has promised us another article, which will appear at the earliest moment—probably in the August issue.—*Editor.*)

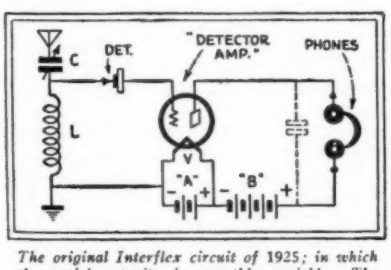


Mr. Treadway's set is extremely simple, and somewhat inexpensive. We cannot recommend it for distance or volume.

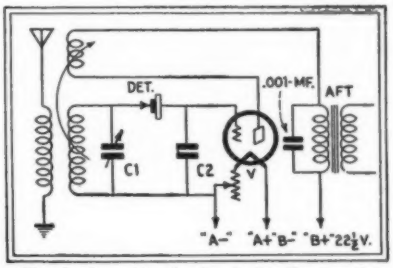
A REDISCOVERY

Editor, RADIO-CRAFT:

Yes sir, this is a swell set. I hope you print it. It uses a 6-volt "A" battery and 10 volts "B"; one variable condenser, and one fixed condenser (out of a Ford coil) with a crystal as a detector. The tube is an '01A. The tapped coil is wound on a tube three inches in diameter and six inches long; it is of No. 22 enameled wire, tapped every eight turns. It looks simple, but it will do its work well if it is built right. Unlike most one-tube sets, there are no whistling noises; but it will sure bring in the distant stations.



The original Interflex circuit of 1925*; in which the aerial capacity is smoothly variable. The actual receiver, however, included more audio amplification.*



The fundamental circuit of the Regenerative Interflex, which old timers will remember for its sensitivity and quality. This receiver used a "Flexicoupler" to control regeneration.

I could not get along without RADIO-CRAFT each month.

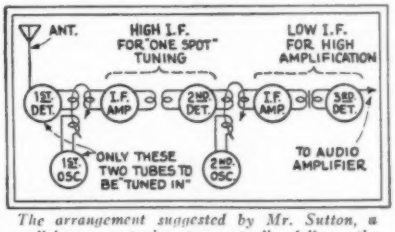
EDWARD TREADWAY,
Reno, Ohio.

(Our correspondent is, no doubt, blessed with a good location and one fairly free from interference; in such a spot, a simple set will do wonders. For comparison with this little set, we show also the fundamental circuits of the Interflex and the Regenerative Interflex which found so many friends among constructors a few years ago.—*Editor*).

DOUBLE CHANGE OF FREQUENCY

Editor, RADIO-CRAFT:

After lying in a semi- dormant state for a number of years, it now appears that the superheterodyne circuit has become quite popular; and I desire to present to you an



The arrangement suggested by Mr. Sutton, a well-known experimenter, actually follows the same principle as a super-converter used with a broadcast set. If the latter also were a super, we would find triple frequency-change.

idea that occurred to me back in the days before all the manufacturers began to feature superheterodyne receivers.

In choosing the intermediate frequency to be used in a superheterodyne circuit, it is desirable for maximum amplification to have the frequency quite low, say about 70 kc. However, so low a frequency brings about the undesirable "two-spot" tuning effect; which gives two separate points on the oscillator dial for every station, and causes loud squeals of protest to emanate from the loud-speaker when the "high" spot for one station happens to coincide with the

(*Continued on page* 50)

RUDOLPH L. DUNCAN, President, RCA Institutes, Inc., Member, Institute of Radio Engineers; Member, Radio Club of America; Member, Veteran Wireless Operators Association; Captain, SCR, United States Army.

A Radio message

To men who are looking ahead!

by R. L. DUNCAN

ONLY a few men will read this message . . . but they will be the type of men in whom I am personally interested. For such men . . . I want to open the door to thorough training in radio. And the coupon below is the first step!

RCA Institutes, Inc., (formerly the Marconi Institute) was founded 22 years ago for one purpose. To produce graduates who will be of *value* to the radio industry. If our Institute never made a penny . . . but did succeed in lifting the standard of radio technicians, engineers, and merchandisers, we would consider our work a success!

Naturally, we want our message to reach as many men as possible. So we founded resident schools in four metropolitan cities. Then we opened our courses to men all over the world who cannot afford to give up their positions. Thousands of our students study at home in their spare time. With the equipment we furnish, they have their own radio laboratory right at home! You, too, can start your course at home *any time!*

Our courses cover the entire radio field. We train beginners who have had no previous knowledge of radio. Advanced students take our more technical courses. But whatever branch of radio interests you . . . is all ready for you to study. The cost is surprisingly low for the training you get.

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SPECIAL NOTICE TO CORRESPONDENTS: ***Ask as many questions as you like, but please observe these rules:***

Furnish sufficient information, and draw a careful diagram when needed, to explain your meaning; use only one side of the paper. *List each question.*

Those questions which are found to represent the greatest general interest will be published here, to the extent that space permits. At least five weeks must elapse between the receipt of a question and the appearance of its answer here.

Replies, magazines, etc., cannot be sent C. O. D.

Inquiries can be answered by mail only when accompanied by 25 cents (stamps) for each separate question. Other inquiries should be marked "For Publication," to avoid misunderstanding.

ERLA "224" SCREEN-GRID

(124) Mr. Joshua Colvin, Phoebus, Va.

(Q.) What are the probable causes of hum or a burnt-out volume control, in an Erla Model 224 A.C. Screen-Grid receiver?

(A.) As the circuit of this receiver indicates (Fig. Q.124), the switch Sw3, which is of "clip" type, connects one phonograph-pickup tip-jack to the chassis; and, if this is not done, hum will result, when the volume control is set in "phono" position. A quick-heater tube may cause a portion of the hum. Test also for the usual opens or shorts; and resistors or condensers of incorrect rating.

A "burnt-out" volume control may not actually be so; but only open-circuited from friction of the slider cutting through the wire. Replacements may be made in accordance with the following values; and voltages checked against figures given below:

Resistors R1, R6, R7, 70,000 ohms; R2, 5,600 ohms; R3, 6,000 ohms (wire-wound volume control); R4, 80 ohms; R5, R8, 100,000 ohms; R9, 1,000 ohms; R10, R11, 10,000 ohms; R12, 6,000 ohms; R13, R14, 20 ohms.

Condensers C1, C2, C3, C4, are the usual tuning capacities, shunted by trimmers (not shown); C5, C15, 0.5-mf.; C6, C7, C8, 12, C13, 0.25-mf.; C9 C10, .001-mf.; C11, C19, 1. mf.; C14, 0.1-mf.; C16, C17, 2 mf.; C18, 3 mf.

The reproducer, with its built-in push-pull output transformer, plugs into the receiver chassis, as shown. It is important to connect the Erla Type P-62 pick-up correctly to the chassis (R, red, to grid and B, black, to chassis) since, otherwise, there may result hum or lack of phonograph volume.

The operating voltages (line-potential 110 volts) are as follows: Filament potentials, V1, V2, V3, V4, V5, 2.4 v.; V6, V7, 2.5 v.; V8, 5v. Screen-grid to cathode, V1, V2, V3, 80 v. Plate to cathode, V1, V2, V3, 165 v.; V4, 65 v.; V5, 95 v.; V6, V7, 245 v.; V8, 350 v. Ground to cathode, V1, V2, V3, 2 v.; V4, 7 v.; V5, 4.5 v.; Grid to filament 50 v.

Weak signals may be due to leakage through the condenser stator shielded leads; and broad tuning, to leakage in the tuning condenser or its stator leads. Cleaning with alcohol should correct this.

ELECTRAD A-224 S-G TUNER

(125) Mr. Paul B. Hammond, Gary, Ind.

(Q.) In the September and December, 1930, issues of RADIO-CRAFT were described two variations of the direct-coupled audio amplifier. Please advise whether the Electrad Loftin-White "Type A-224" screen-grid tuner can be added to these audio systems; and whether it is necessary to add one more tube as a detector?

(A.) The circuit of this "Type A-224" tuner is shown in Fig. Q.125, with the wiring cross-connecting it to a direct-coupled audio amplifier. This tuning unit was designed for use in conjunction with the Electrad Loftin-White "Type A-245" direct-coupled audio amplifier; when it is connected to such an audio system, the first tube in the audio amplifier functions as a detector, no additional tube being needed.

The circuit of the "A245" will be found in the "Radio Robot" article on page 24 of this issue.

(*Continued on page 59*)

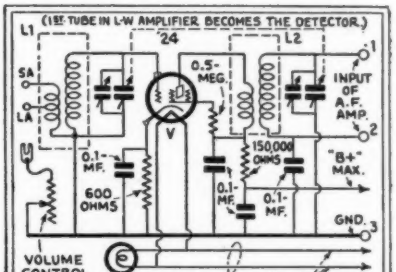


Fig. Q.125. (Above)

Electrad Loftin-White "Type A-224" Screen-Grid Tuner, designed to operate with the "Type A-245" Direct-Coupled Audio Amplifier.

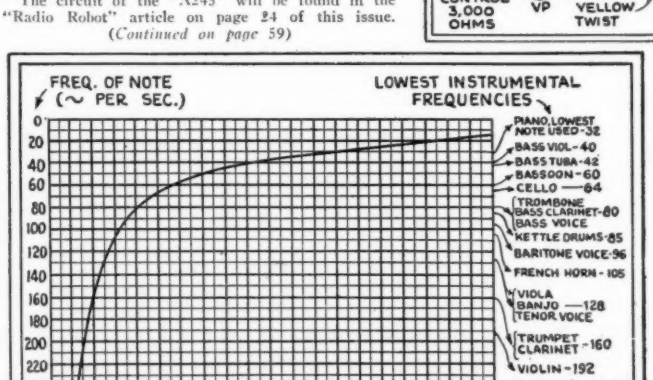


Fig. Q.126. (Left)

This graph, reproduced by special permission of the author, Mr. Alfred A. Ghirardi, and the Pilot Radio and Tube Co., is reprinted from the Spring, 1931, issue of Radio Design; *it illustrates the relation of the baffle's length to the cut-off frequency (left column of figures).*

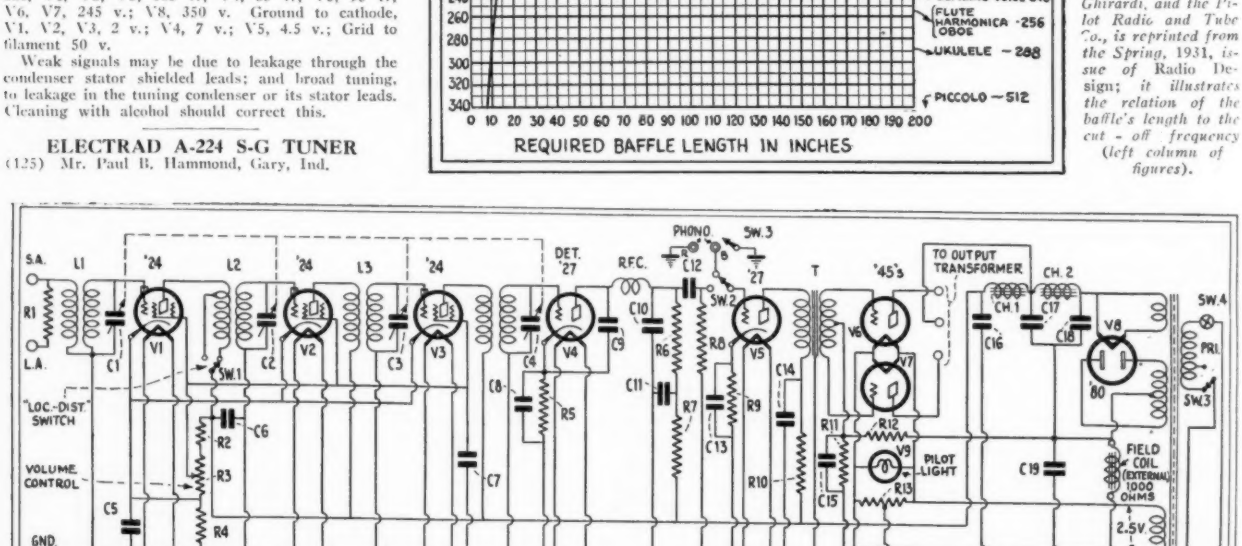


Fig. Q.124.

Schematic circuit of the Erla "Model 224 A.C. Screen-Grid" receiver; trimmer condensers, not shown, shunt the tuning condensers. Note that the external reproducer field, by-passed by condensers C15 and C19, and the shunt R11, is connected in the center-tap lead to high-voltage secondary.

The Super-Converter

(*Continued from page 23*)

Housed in an attractive, beautifully finished, compact all-metal cabinet, the Walker Super-Converter blends in harmony with the most beautiful and correct furniture setting. The '80 tube, used to furnish plate voltages solely for the converter, has a longer life at smaller cost. None but the finest of materials are used in the converter; and every effort has been exercised in the construction of a truly reliable and efficient short-wave device.

This is perhaps the very first short-wave converter offered to short-wave enthusiasts in which the design parallels that of standard broadcast receivers. The fan may have confidence, because of its attractive cabinet appearance, on introducing to the family Walker Model 4, Super-Converter.

New Accessories

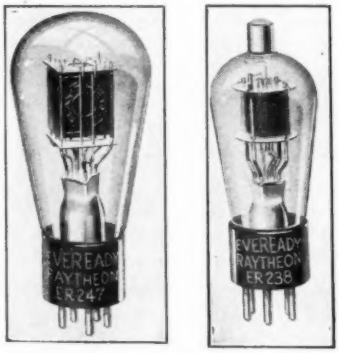
(*Continued from page 23*)

rather an expensive item; but it is cheaper to replace one of these little resistors than a more expensive item, such as a power transformer.

Its installation is simplicity itself. The two-pronged regulator plugs into a light-line receptacle, while into its opposite end is plugged the power plug of the radio set. (*Clarostat Mfg. Co., Brooklyn, N. Y. City.*)

"FOUR-PILLAR" TUBE DESIGN

LATELY tube types have been appearing, not singly, but in droves. Their average characteristics, in various makes, are usually very much the same: however, a difference of opinion has been manifested in the new variable-mu tubes, of which two type numbers are now standard. One manufacturer, however, has brought out variable-mu tubes in both the '35 and the '51, to



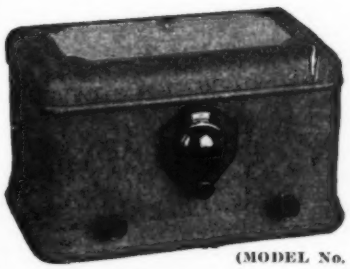
Two of the new Eveready pentodes.

suit different receiver designs. The former has a plate resistance of 300,000 ohms and an amplification factor of 300; the latter has a resistance of 400,000 ohms and an amplification factor of 420, drawing therefore a slightly smaller plate current. In addition, this line includes the new pentodes, both A.C. and D.C. types, and the 6.3-volt tubes introduced for automotive work.

The feature of their construction is in the arrangement of the supports for the elements of the tubes, which gives not only rigidity, but maximum clearance and low

GEORGE W. WALKER

SUPER-CONVERTER



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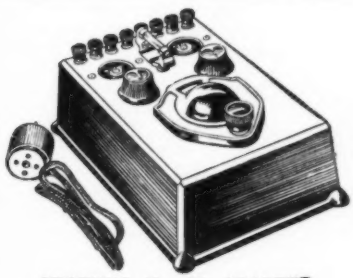

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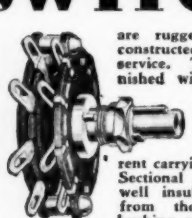
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ELLIS Microphones for TONE

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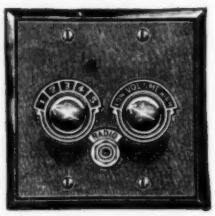
capacity between the electrodes. Its distinctly rugged appearance marks the illustrations of two of these "four-pillar" tubes, showing the assemblies.

(*National Carbon Co., New York City.*)

OUTLET PLATES

RADIO wiring, as in hotels, apartments, new homes, etc., requires special developments, of fixtures suited to the many diverse circuits employed. The wall plate illustrated, for instance, is adapted to a five-channel radio distributing system with master amplifiers, and affords volume control as well. Other models combine a 110-volt receptacle also. Some twenty-five types are available, in brushed brass or brown molded bakelite face plates, ranging from



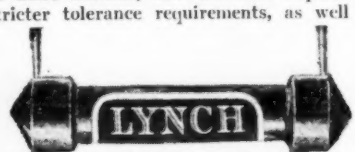
One of the numerous types of Carter radio convenience outlets for single and multiple installations.

a simple antenna connection to the more complex devices. These plates are approved by the Underwriters Laboratories.

(*Carter Radio Co., Chicago, Ill.*)

NEW RESISTOR TYPES

RESISTORS of the metallized type are now available with a filament of a new design, described by the manufacturer under the term "K," which is stronger as well as more durable, and therefore capable of stricter tolerance requirements, as well as



Lynch "Type K" metallized-filament resistor.

able to endure greater overload. These resistors are manufactured in cartridge and pigtail types, at wattage ratings from 0.5 to 5.

In addition, improved wire-wound resistors are also available in both types, to meet individual requirements, in all values from one ohm to half a megohm; cartridges also from 0.5 to 2.5 megohms. In the wire-wound, as in the metallized units, contact

Lynch wire-wound precision resistor.

is made permanent by the use of a molded metal end cap which protects against deterioration and therefore noise. The wire-wound resistors are rated at one watt, with a tolerance in value of 1% plus or minus.

(*Lynch Mfg. Co., New York City.*)

TWO-VOLT PENTODE

WHILE the '31 type tube provided a power amplifier suitable for two-volt sets, the qualifications of the pentode as the power stage *par excellence* for battery operation made it certain that this design of tube would be forthcoming.

The C-333 tube, which has just become available for set constructors as well as manufacturers, draws 260 milliamperes on the filament at 2 volts—double the current of the '31. It gives, however, four times the output, or 650 milliwatts undistorted output, at 135 volts on both plate and screen. The plate current is given as 14 milliamps, and the screen current at 3. The tube has an amplification factor of 63; a plate resistance of 45,000 ohms; and a mutual conductance, therefore, of 1400 micromhos. It has next the plate a "suppressor grid" which is connected internally to the filament.

The recommended impedance load in the tube's output is 7,500 ohms; and this value should be maintained fairly constant, to limit distortion to a minimum. The manufacturers advise against the use of this pentode in series with the filaments of other tubes, and recommend that a proper meter be used to check its operation.

(*E. T. Cunningham, Inc., New York City*)

VOLUME CONTROL UNITS

Carter volume control resistor and power switch combination.

WIRE-WOUND volume controls, in the resistances demanded by various circuits, are available, with or without included switches, in values from 0.5 to 20,000 ohms; with resistance values uniform or tapering at either end; and in straight resistor or potentiometer arrangements. The units are very compact and rugged; they are furnished with single-hole mountings.

(*Carter Radio Co., Chicago, Illinois.*)

PORTABLE PROJECTOR AMPLIFIER

AN amplifier which is completely A.C. operated, yet so carefully made as to function perfectly in field service in connection with photoelectric cells in sound

Operadio "Type 408" portable amplifier.

work is illustrated here; it is designed especially for use with sound-on-film, in conjunction with caesium-type photoelectric cells. It takes its input energy direct from the PE cell, the voltages necessary for which as well as for the filament of the exciter lamp, are delivered by the amplifier.

Emphasis is placed upon the fact that no batteries are required or used in this amplifier.

The design is such that the portable projector amplifier may be mounted on the wall of a projection booth, between the projectors; or it may be put in a convenient carrying case. It measures 19 x 21 x 8 in. deep.

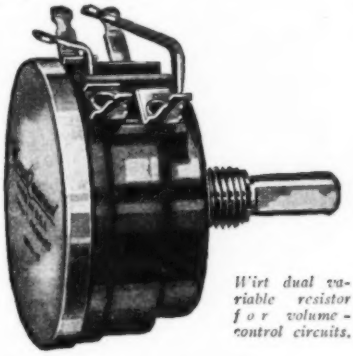
(*Operadio Mfg. Co., St. Charles, Ill.*)

UNDERGROUND SOLDERING

A SELF-SOLDERING ground post has been produced by an English manufacturer, which is rather novel in this feature. It is a pipe with a brass point, so that it may be driven into the ground until only the end protrudes. At the upper end is a brass cap, to assist in hammering down the pipe; under this is a small cup to hold denatured alcohol. After the pipe has been driven home, the end of the ground lead from the set is placed in the cup, with solder; and the alcohol is lighted, melting the solder and completing the connection.

DUAL VOLUME CONTROL

MANY radio receiver circuits demand variation of resistors simultaneously in two entirely isolated portions of the circuit; where neither circuit has a connection common to the other. The dual control illustrated being wire-wound, will operate non-microphonically in circuits carrying relatively high current. The standard case, illustrated, is 1¾ inches in diameter, and two inches high, one inch being due to the shaft. It will accommodate a 7,500 ohm resistance strip. For higher values, there are special casings.



Wirt dual variable resistor for volume-control circuits.

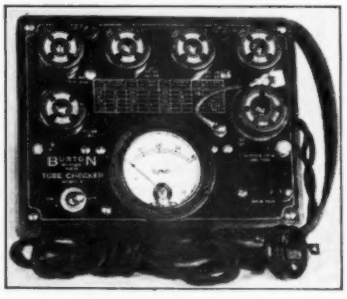
The resistance wire is wound on bakelite, and over it ride two nickel-silver spring contacts; six soldering lugs are provided for connection to the twin potentiometers. The unit fastens to the panel by means of the usual locknut.

The construction is of "noiseless" type, lubricated; and, to prevent dust particles causing noisy operation, is provided with a metal cap which fits tightly over the mechanism.

(*Wirt Company, Philadelphia, Penna.*)

Latest Testing Equipment

(*Continued from page* 11)



Burton-Rogers "Model 3" tube checker.

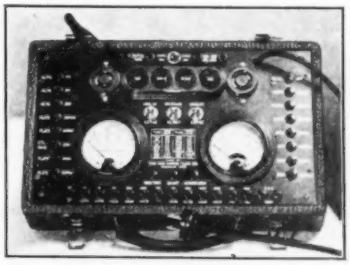
shorted. Six sockets enable testing any type tube—and under rated filament, grid and plate conditions (grid-bias adjustment for each tube being obtained automatically). Three push-buttons are provided to control the circuits.

(*Burton-Rogers Co., Boston, Mass.*).

ANALYZER AND CHECKER

COMPLETENESS in servicing equipment is excellently illustrated by this combination instrument for precision testing, both of receivers and of their tubes separately. Eleven meter ranges are also available for external tests, by means of pin-jacks. The meters are precision instruments; the A. C. meter (left) having a double movement to permit lowest current consumption; and the D. C. meter being a 1000-ohm-per-volt type. With the elaborate switching equipment illustrated, care has been taken with the circuit arrangement so that it is impossible to damage it by incorrect operation. Meter readings cover up to 800 volts and 100 milliamps; higher scales may be obtained on special order. The equipment is housed in a black molded bakelite carrying case, which affords room for the necessary test leads and other accessories.

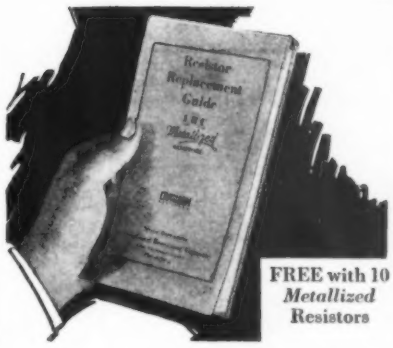
(*Van Horne Tube Co., Franklin, Ohio.*)



Flewelling Van-Horne "Model H" analyzer.

NEW TUBE CHECKER

THIS instrument indicates the "end of life" or at least the stage of service, of all types of amplifier, power and rectifier tubes; tests separately the plates of '80-type rectifiers; and, through an ingenious



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Genuine "ALCOA" stock, silverdip finish, 5 x 9 x 6, $1.89—14 x 6 x 6, $3.85. 10 x 6 x 7 Monitor size $3.25. 5 x 5 x 5 Coil Shield (like picture on right) $1.00.
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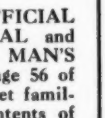

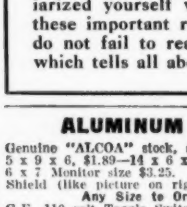

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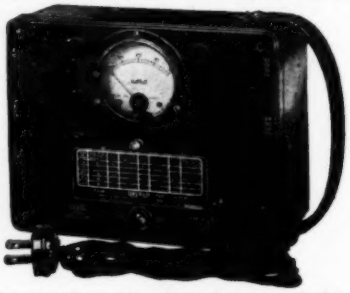
arrangement upon which patents are pending, tests for noisy tubes. It is self-biasing.

Six sockets are provided, so that tests may be made at the rated filament voltages. Colored buttons simplify the operation of the tube checker. The meter incorporated has a 0-40 scale and a D'Arsonval movement. It is supplied with or without lid,



Dayrad "Type L" self-biasing tube checker.

and in a professional carrying case, for A.C. operation at all commercial voltages and frequencies.

(*Radio Products Co., Dayton, Ohio.*)

SHORT-WAVE ADAPTERS

SHORT-WAVE adapters, exhibiting a family resemblance, since they are the latest children of the well-known short-wave designer, E. T. Flewelling, are available in several models. That illustrated employs three tubes; a '24, a '27 and an '80, since its power supply is self-contained. It works on the frequency-changing principle, feeding into the antenna circuit of a broadcast receiver. With the three sets (each of two) of plug-in coils supplied, the band from 15 to 180 meters is covered. It operates on 110 volts, 60 cycles, from the light line. A switch gives the choice of long or short-wave reception without disconnecting the adapter. The size is 10x7x3¾ inches, and the weight about 12 pounds.

A two-tube model of similar type, but without the rectifier, derives its plate supply from the receiver, or a suitable dry battery; its filament transformer may be obtained for 25-cycle or for 220-volt operation, if needed.

A "midget" two-tube adapter is also available; it has a black molded bakelite case, 7x5x1⅞ inches, and uses two type '27 tubes, with but one coil for each waveband, over the 15-180 meter range. The sole control required is a vernier dial. In this model, the panel is horizontal, and the tubes are mounted externally.

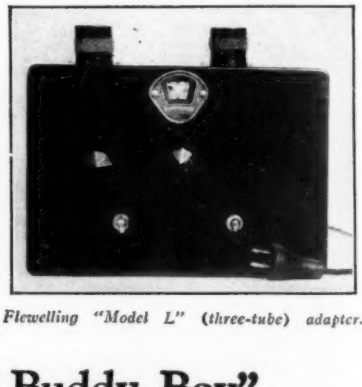
(*Van Horne Tube Co., Franklin, Ohio.*)

Service Notebooks

(*Continued from page* 15)

spool, it is only necessary to unwind one turn of wire and then connect and solder to the terminal; leaving a little slack so the wire won't break again. If the break is at the inside terminal, it will be necessary to install a new R.F. transformer unless the end of the broken wire is long enough to resolder.

The tone control used on the "96-111" series can easily be installed on the "Model 95" by doing away with the "local-distance" switch. Cut off the wires leading from it at the small 20-ohm resistor which is located on the antenna coil; then remove the switch. To install the tone control, bend the lip on the chassis (which held the "L-D" switch) forward to allow the shaft to enter hole in lip. After entering shaft in hole, bend lip back to original position and fasten tone control in position. Run a wire from the terminal on the tone control, to plate of first A.F. tube, and installation is finished. The tone control is Philco part No. 4037A, and is only 65 cents list price.



Flewelling "Model L" (three-tube) adapter.

Crosley "Super Buddy Boy"

(*Continued from page* 21)

lyne receiver, measuring only 15¾ x 15¼ x 9 11/16 in. deep, is a model of efficiency and a notable demonstration of the possibilities of the newest vacuum tubes.

For the consideration of technicians and the convenience of Service Men, the following technical data are appended:

Volume control resistor R1 has a value of 2,500 ohms; R2, 1100 ohms; R3, R12, R15, 1.0 meg.; R4, 45 ohms; R5, 1220 ohms; R6, 2150 ohms; R7, 3,000 ohms; R8, 6,500 ohms; R9, 3,500 ohms; R10, 300,000 ohms; R11, 60,000 ohms; R13, 0.5-meg.; R14, 25,000-40,000 ohms; R16, 2,000 ohms; R17, 20,000 ohms; R18, 10,000 ohms; R19, 220 ohms; R20, center-tapped resistor.

Condensers C1, C2, C3, constitute the tuning gang; and C1A, C2A, C3A, their trimmer capacities. Condensers C4A and C4B are I.F. trimmers. Condensers C5, C7, C11, C13, C15, have a capacity of 0.5-mf.; C6, C9, 0.1-mf.; C8, 1. mf.; C10, C14, C17, .02-mf.; C12, .001-mf.; C16, .002-mf.; C18, C19, 8 mf. electrolytic condensers.

Average operating voltages follow. Filament potentials: V1-V6, 2.4 volts; V7, 4.8 volts. Plate potentials: V1 and V4, 180 volts; V2, V5, 200 volts; V3, 33 volts; V6, 280 volts; V7, 300 volts (each plate). Screen-grid potentials: V1, V4, 50 volts; V2, V5, 7 volts; V3, 90 volts; V6, 280 volts. Control-grid potentials: V1, V4, 2 volts; V2, 7 volts; V5, 9 volts; V6, 20 volts. Plate and grid potentials are measured with a meter of 600 ohms per volt, or higher resistance; with reproducer connected, volume control full on, and line-potential of 117½ volts.

Operating Notes

(*Continued from page* 14)

was being received. To provide for this, a S.P.S.T. switch was mounted on the cabinet front, in series with one leg of the 400-ohm shunt, and marked "Local-Distance." An even better stunt, though more difficult, is to mount a variable resistor (about 10,000 ohms) on the cabinet front, and connect it across the two lugs on the terminal strip. When the full resistance is used, it will have no effect on the circuit but, as the resistance is varied, it will be found that best results with various stations are obtained at different settings. Operation with this method is more efficient than the first, but less simple.

Adjusting Compensating Condensers

The new Philco "Model 111" super presents a formidable appearance when it comes in for realignment. It has nine adjustments; these for the first I.F. primary and secondary are made from beneath the chassis, the rest from above. This set uses an intermediate frequency of 175 kc.; first adjust the I.F. stages at this frequency (in order 3, 2, 1), and then adjust the high-frequency condenser at 1,400 kc. when the dial reads in conformity with this frequency. The low-frequency is then adjusted at 600 kc. The two antenna compensators may be adjusted before or after this procedure; at about 1400 kc. for maximum reception. All adjustments are made for maximum response with an accurately-calibrated oscillator. Do not forget the detector compensator. (See Data Sheet 45, page 12.)

"That elusive hum" was recently encountered on a Majestic "90" chassis; the hum was apparent off the station, but at resonance it was very loud. This condition was caused by an open filter condenser in the pack; hum on resonance may be caused by any condenser after the choke.

A cause of intermittent and noisy reception on Kennedy "Model 526" has been found in a faulty compensating condenser; there are two of these. In order to adjust them, the shields must be taken off the screen-grid tubes. The adjusting screws look like simple mounting screws; they are located on the condenser housing between the first and second '24's, and between the third '24 and '27. When the insulation cracks, it is usually necessary to replace these.

The Radiola "44" and "46" include a "local-distance" S.P.D.T. switch which grounds the antenna loading coil through a .00023-mf. condenser when at local setting. When a complaint of feeble reception on the "local" position is received, it may usually be corrected in the following manner. Remove the chassis; the compensating condenser adjustments are located in the front. They are plain flat-head screws, flush with the chassis. Align the set with the switch in "local" position. It may be that replacement of the .00023-mf. condenser is necessary; if this opens, or alters its capacity, the receiver will not be properly grounded.

On the Brunswick "S-31" phonograph combination, intermittent action may be caused by the 0.1-mf. tubular condenser, one terminal of which is soldered to one of the lugs of the radio-transfer switch.

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by

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Whatever your problems in connection with radio service work, the 1931 Trouble Shooter's Manual will supply you with the vital data concerning the circuit, the socket layout, the set analyzer voltage data, the color code, the internal connections of enclosed units, chassis structure, peculiarities in the radio receiver.

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For the first time since the existence of the radio service industry, ONE book contains ALL valuable data. We want you to understand that John F. Rider spent nineteen (19) months compiling this book. In it you will find the WHOLE line of receivers manufactured by the popular American and Canadian receiver manufacturers.

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Section 5.—Wiring diagrams of public address and power amplifiers, inclusive of the products of the most famous manufacturers.
Section 6.—Wiring diagrams of ALL popular eliminators and power packs.
Section 7.—Wiring diagrams of ALL popular short wave receivers and adaptors.
Section 8.—Wiring diagrams of ALL popular kit receivers, old and new.
Section 9.—Wiring diagrams of the popular Set Analyzers, old and new.
Section 10.—Wiring diagrams of midget receivers.
Section 11.—Peculiarities in radio receivers, a section which you can remove from the book, bind separately and carry with you. This section is a distinct innovation in radio service literature. It will tell you of any special features which you must know of when testing the receiver. Every commercial receiver in the 1931 Trouble Shooter's Manual by Rider is mentioned in this section.

No matter what other books you may have, YOU NEED THE 1931 TROUBLE SHOOTER'S MANUAL because it includes many diagrams and details which have NEVER BEFORE appeared elsewhere. . . . This book contains many diagrams which are not available from any other source. . . . Remember that one diagram with color code may save you enough time and enable you to complete a successful repair in such fashion that it will repay you for the entire cost of this book. . . . Hot off the press!

The free question and answer service personally conducted by John F. Rider will be worth a lot of money to you. . . . It is FREE with the 1931 Trouble Shooter's Manual. . . .

The book is loose leaf, beautifully bound. The pages are 8½ x 11 inches. The drawings are large and easy to read. ALL of the vital data is shown upon the same page. Electrical constants are furnished . . . No expense was spared to compile this book. IT WEIGHS 6 POUNDS. . . . Every man who is doing service work should have this book!

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NEW METHOD MFG. CO.
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Construction of the Radio Robot

(*Continued from page* 26)

Two Durham 10,000-ohm "metallized" resistors, R5, R10;
Two Durham 1-meg. (1-watt) "metallized" resistors, R6, R7;
One Electrad 10,000-ohm Type B-100 resistor, R11;
One Electrad 21,000-ohm "Type 250" voltage divider, R12;
One Electrad 750-ohm "Type B 7.5" wirewound "Truvolt" resistor, R13;
One Electrad 50-ohm "Type V" resistor, R14;
Four Polymet 1-mf. "Type A" by-pass condensers, C1, C2, C4, C5;
One Polymet .01-mf. mica-dielectric fixed condenser, C3;
Two Polymet 4-mf. "Type C" filter condensers, C6, C7;
One Polymet 2-mf. "Type C" filter condenser, C8;
Two UY sockets, for V1, V2;
Four UX sockets, for V3, V4, V5, V6;
One Arcturus "Type 124" screen-grid tube, V1;
One Arcturus "Type 127" tube, V2;
Two Arcturus "Type 150" power tubes, V3, V4;
Two Arcturus "Type 181" half-wave rectifiers, V5, V6;

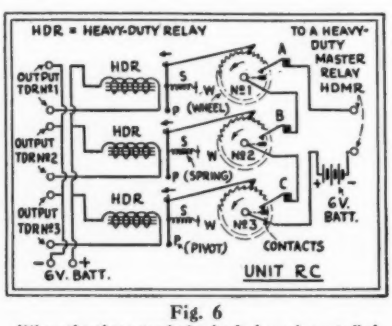


Fig. 6
When the three toothed wheels have been pulled around, then only does the relay operate.

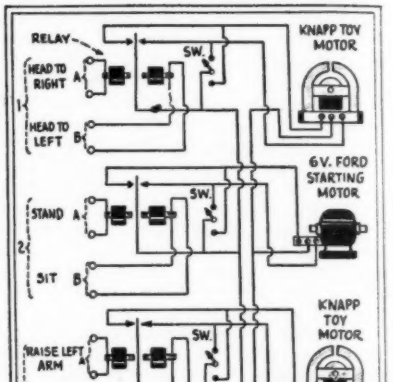


Fig. 7
Three channels turn the head one way, raise the left arm, or the whole figure. Three more reverse the directions of motion.

Two Amertran 30 hy. "Type 854" filter chokes, Ch1, Ch2;
One Amertran "Type PF-250A" power transformer, PT;
One Amertran "Type H-4648" power transformer, PF;
Two Universal two-button microphones, M1, M2;
Four binding posts, 1, 2, 3, 4;
One control-grid clip for V1;
One aluminum chassis (size optional).

(*In August* RADIO-CRAFT, *Mr. Cisin will explain light-ray and phonograph record control of the robot, with other details of operation.*)

Choosing Replacement Resistors

(*Continued from page* 17)

If we reduce this to plain figures, for the case given above, we shall find that at a screen-grid voltage of 90 and a normal effective impedance load of 100,000 ohms, the gain is equal to

$$\frac{400 \times 100{,}000}{400{,}000 + 100{,}000} = 80$$

whereas, when the screen-grid voltage is reduced to 50, the gain is only

$$\frac{800 \times 100{,}000}{1{,}200{,}000 + 100{,}000} = 61.6$$

The above shows how seriously the gain per stage (i.e., sensitivity) has been affected through the use of a poor quality resistor.

Many kinds of trouble may appear when cheap replacement resistors are used, but, regardless of the exact way in which the trouble manifests itself, it is sure to constitute a direct reflection on the ability and skill of the Service Man.

When a radio set has just been repaired, the owner cannot be blamed for losing confidence, if it promptly develops new troubles or stops working altogether. The natural inference is that the Service Man did not understand his work, or that he performed an inferior repair job. It goes without saying that no radio man wants to risk the loss of his good reputation in this or any other such way.

The Service Man, however, invariably has many other things to worry about, besides rigging up meters to test every resistor that he uses. How then, can he be reasonably certain that he is using the *specified values?*

The answer to this important question should serve as a guide to every reputable radio Service Man. *All uncertainty can be eliminated by the use of standard, advertised and guaranteed resistors.* Even if such resistors cost a little more at first, they are cheaper in the long run; since they give perfect performance and thus establish customer confidence and build up a lasting business for the Service Man.

The Latest Small Sets

(*Continued from page* 21)

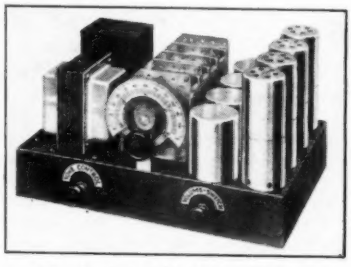
AN ATTRACTIVE MIDGET

THE "Vitatone" Midget radio set features a "full-vision" type tuning scale, graduated from 0 to 100. A 3-amp. automotive-type fuse is the protective device in the power input circuit; this fuse clips into one of two positions, thus adjusting the input connections for high or low line voltage.

Three type '24 tubes are used in the R.F. circuit; their amplified output is fed into a type '27 power detector, the output of which feeds a type '45 power tube. In the plate circuit of the last is connected, from plate to chassis, the tone control, consisting of a 10,000-ohm variable resistor in series with an 0.5-mf. fixed condenser. An '80 completes the tube kit.

Volume is controlled by the simple process of shunting a 1,000-ohm variable resistor across the first R.F. transformer's primary. The volume control in this receiver is combined with the off-on switch. The dynamic reproducer used in the "Vitatone" receiver has a 2,500-ohm field; which connects in the "B+" power lead as one of the two filter chokes.

The instruction sheet which this manufacturer furnishes to the set owner contains a piece of advice which, though not profound, is at least uncommon in this form. It reads: "In all cases, do not attempt to repair the set yourself. Call a competent



Chassis of the "Model 54" Vitatone.

Service Man; otherwise your guarantee will be nullified and void." It is accompanied by the circuit diagram and operating voltages. (*Zaney-Gill Corp., Chicago, Ill.*)

NEW SUPERHETERODYNES

FOUR superheterodyne receivers have been introduced under the Clarion banner: "Model 80" 7-tube, mantel-type; "Model 81" 7-tube console; "Model 90" 8-tube mantel-type; and "Model 91" 8-tube console. Their two outstanding circuit differences are described below: at the same time, attention is called to a Data Sheet, covering the Clarion "90" series, in this issue.

Six tubes are used in the fundamental "80" series superheterodyne circuit. "Variable-mu" and "pentode"—the latest words in tubes—are found in both the "Model 80" and the "81" receivers; three of the former, of '51 type, being used as first R.F., first detector, and first I.F., positions, and the latter as a power output tube. A screen-grid type '24 is used as the second detector; and a type '27 functions as the oscillator. The rectifier is an '80.

A switch-operated tone control connects a .02-mf. fixed condenser across the primary of the output audio transformer. Volume is controlled by varying the potential on the cathodes of the two '51's used as amplifiers; the circuit includes, between cathodes and chassis, a 10,500-ohm variable resistor and a 230-ohm fixed resistor. The detector is resistance-capacity coupled to the pentode. The reproducer's field coil is connected in the "B—" lead.

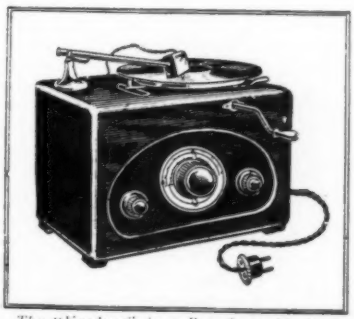
Exterior of the "Model 90" Clarion.

Automatic volume control, added to the circuit used in the "80" Series Clarion receivers (and the circuit modified accordingly) produces substantially the connections that constitute the "90" Series Clarion receivers; as shown in the Data Sheet (No. 46) previously referred to. The automatic-volume-control tube is a screen-grid '24. The tone control in this model is smoothly adjustable.

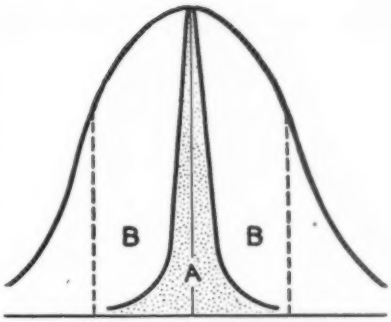
(*Transformer Corporation of America, Chicago, Ill.*)

A RADIO PHONOGRAPH

IN the combination illustrated here, a French manufacturer has found what is very nearly ultimate simplicity. The receiver is of the regenerative type still very common in Europe, with two stages of audio following; the latter are used with the phonograph pickup. While the arrangement is not especially attractive, compared with the elaborate consoles used here, it is quite inexpensive. An external loud speaker is required.



The "Vradyne" is a French combinaiton.



Inner curve shows Stenode's selectivity, outer curve that of ordinary receiver. Lines BB are 5 k. c. distant from Line A. All background noise included in the light portion between A and BB is eliminated by the Stenode.

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Until the American Tube Manufacturers licensed by the Stenode Corporation of America are in sufficient production, we can supply the rapidly growing demand of laboratories and serious investigators for:

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All crystals are ground to respond to a frequency of 175 kilocycles, which is the frequency accepted as standard in all modern superheterodynes, and are mounted in vacuum tube form.

STENODE TUBES (Standard UX Socket Base) **Price $15**

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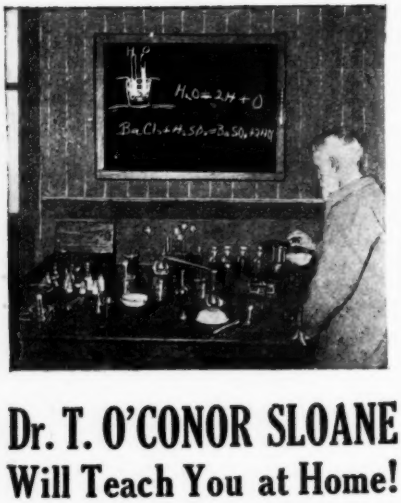
Street.....

City.....State.....



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CITY..... STATE.....

Making Money in Radio Servicing

(*Continued from page* 15)

Use your own ideas, coupled with those of others. To amplify this statement, I cite one instance where I used another fellow's idea but did the job differently; I refer to using the new 2-volt tubes in the "Radiola 28." I made two adapters, one containing a 750-ohm resistor and one with a 4-ohm resistor; this saved opening up the catacomb. All changes were made externally; thus saving a great deal of time and labor.

Don't tell your customer, "It can't be done;" because *it can be done* and, if you don't do it, some other enterprising Service Man will do it and you will lose both the business and the good will.

I hope these few lines will impress you with the fact that our job is to sell service; and real service pays.

(Mr. Smith closed his letter with a generous offer to assist any Service Man with advice on these jobs. However, all these subjects have been the themes of articles in recent issues of RADIO-CRAFT. Tone controls, for instance, were discussed in the January and February issues of this year; operating battery sets from the D.C. line in the October, 1930, issue; power grid-leak detection and conversion of old Radiolas for 2-volt tubes in the May, 1931, issue; and there have been repeated articles on frequency-changing, short-wave converters. The Service Man should consult all sources of published information before writing for advice; and when writing to a fellow Service Man, or an author, for personal advice on a specific problem which is not covered, he should enclose, not a stamp but a stamped and self-addressed envelope of good size and quality.—*Service Editor.*)

The Open Forum

(*Continued from page* 16)

selling his product, not in keeping it sold. The manufacturer advertises his product and creates the demand—the Service Man comes along and says: "Keep your old set and let me make it like new." The salesman: "Throw it away or trade it in for a new up-to-date one." I don't pretend to know the solution to this situation but I have an idea which might be of help.

I think a customer's radio should give him the best of service which the type owned is capable of, until the time comes when the customer wants to buy a new one; as there is no one who does not want to take advantage of the improvements and refinements that come with progress. This cannot be done without manufacturers' co-operation. The salesman should thoroughly demonstrate his machine and acquaint the prospective owner what to expect from his set, and what it will not do. It is not a Service Man's job to go out and explain the phenomena of fading, and why they can't get the old home town every night, etc.

It is my policy never to advise a customer to spend more than one third of what the set would bring at market prices in order to repair it. This I think is fair to the customer, the salesman, and the manufacturer. It is very hard to procure service notes and other technical information from manufacturers whose sets you do not handle; I can't understand why, if you are capable of servicing several other standard makes. I am a dealer's Service Man, and my house repairs all makes of radios. I think the evil of supplying would-be Service Men with notes is more than offset by depriving the deserving ones of them (that, I believe is the general excuse).

In closing, I would like to say that I get more real information from your magazine (and other publications I subscribe to) in one month than I do from the manufacturers themselves in several months; and it is at my own expense too. Think this over, fellows.

Following are a couple of "Hints to Manufacturers." Put some kind of backs to cabinets; the lack of this has been commented on numbers of times by customers. I think all service notes should be drawn with condensers, chokes, resistors, and etc., indicated as to value and not by color scheme (as some are doing for resistors); as this makes it harder to substitute when defective part is not readily procurable.

I am making a list of common ailments of sets which we handle, that may be of use to some other Service Man. Wishing you continued success I am,

Very truly yours,

.....

Atlanta, Georgia.

(*We shall be very glad to hear again from our correspondent, who made the oversight of omitting to sign his name before closing the letter.*—Editor.)

LICENSES FOR SERVICE MEN

Editor, RADIO-CRAFT:

I see by the papers, and some of the magazines, that some states are considering measures to compel any man wishing to do radio work to pass an examination as to his qualifications. This certainly would be a very great boost for the professional Service Man; as the radio field would be cleared of a great number of those overnight radio mechanics. Any honest, thinking radio man who has spent his time and money and burned the midnight oil in studying the advanced science of modern radio, and to keep abreast of the new developments, will certainly welcome such a measure and clasp the hand of the man putting it over. Any good electrician in any of our cities must pass an examination before being eligible to do any work in his profession, and he is reimbursed with at least $1 an hour for his services. Why shoud not the Radio Service Man have the same privilege, both as to the examination and the reimbursement?

Any radio man worthy of the name will undoubtedly pass the examination; of course it will be the acid test to a great many who think they are Service Men. Only the best will survive, but those remaining will be only more proud of the place they fill in today's industrial world. After such a measure is put through, the organizing of radio servicing as a profession will be the follow-up to make the field clean. I hope that printing these few lines will help to foster the proposition.

MICHAEL J. REEFF,
Alton, Iowa.

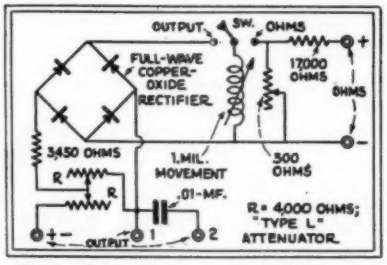
An Oscillator for Modern Servicing

(*Continued from page* 11)

UX tube adapters, serve to attach the output meter to the two plate leads of a push-pull amplifier output or to the plate lead of a single output tube and the set's chassis.

First turn the radio set "off." Then remove the set power tube or tubes; place these in the adapters; and put tubes and adapters back in the sockets. The other ends of the leads should then be connected to the terminals provided for them on the output meter; of these, there are three: a common terminal and two others marked "1" and "2." Terminal "2" has in series with it a fixed blocking condenser to prevent the passage of D.C., but allow the set's A.C. output to pass through.

The common terminal and terminal "2" should be used for all sets; but terminal "1" and the common terminal may be connected across a voice coil when so desired. The switch on the output meter should then be thrown to the "output" position, and the attenuator control knob to the full counter-clockwise position. Then turn the set "on," and place the oscillator in operation.



Circuit of the output meter, showing the use of the rectifier to measure alternating current, with uniform accuracy to 5000 cycles.

The oscillator is now supplying a signal, which is received and detected by the radio. As soon as the radio tubes warm up, the signal will be indicated by a reading on the output meter's scale. It will be necessary to tune the radio and the oscillator to the desired signal; and also to adjust the attenuator control on the output meter until the scale reading is properly indicated at a convenient point on the arbitrary scale.

The output from the oscillator may be varied by means of the variable resistor R1 in the diagram, and the attenuator on the output meter may be varied also; thus, a wide range of outputs can be covered. In this way, the necessary aligning adjustments can be made, on both broadcast and intermediate amplifiers, the maximum scale reading on the output meter indicating the condition of resonance.

Measuring Pentode's Output

The pentode output tube is now becoming very popular, and manufacturers are beginning to incorporate this type of tube in their receivers. As this tube has five prongs, it will be necessary to use a five-hole adapter on the output meter leads for making connection. As an alternative, the output meter's leads may be connected directly across the voice coil of a dynamic loud speaker; the output meter is so arranged that it will not materially affect the impedance of the voice coil. This instrument will also be found useful, when adjusting for minimum hum level in A.C. receivers.

It will be noted that the modulation of the oscillator signal is fully 100%, when using the A.C. lighting line; it is also nearly 100% when employing grid-leak modulation. This is a distinct advantage when making tests on receivers which use power detection. For, if a strong unmodulated signal is applied to the input of a power detector, it is possible to overload the detector without obtaining any loudspeaker output. Then, too, if the R.F. energy is only slightly modulated, in some sets this may result in two apparent resonance peaks; and the set appears to be broadly tuned. Therefore, it is necessary that the oscillator signal be modulated as near to 100% as possible.

To use the output meter for measuring resistances, simply throw the switch to the "Ohms" position, and connect the proper leads provided with the instrument to the 22½-volt terminals on the oscillator panel. With the test leads shorted, set the "zero ohm" adjuster till the meter reads zero; then the meter will indicate the values of resistors, placed between the two set terminals.

Although fundamentally simple in design and operation, this instrument can be used for all oscillator tests outlined in the various manufacturers' service manuals. It offers servicing possibilities heretofore available only with highly-complicated and expensive apparatus.

Hints for Manufacturers

(*Continued from page* 17)

people who are very hard of hearing. In this manner, also, radio listeners, who enjoy late programs, may listen without disturbing persons who are asleep or who may want to enjoy different programs. I am employed in a radio store where quite a few inquiries have been made on this suggestion.

CHARLES VITANZA,
3606 *Atlantic Ave., Atlantic City, N. J.*

(This is the experience, evidently, of many dealers and Service Men. Some have made additional money restoring the jack which was once found in every audio stage.
—*Editor*)

Wanted, Hinged Fronts

IT seems to me that it would be a good plan, when building cabinets for receivers, to make the front side swing out on hinges; permitting inspection and testing of the receiver without having to twist the cabinet around on the floor (or rugs as the case may be) in order to get at the back to do the job. This is a complaint that is very often made to me, when servicing receivers.

C. L. MERRELL,
Selmer, Tennessee.

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Tube Checker

MODEL 19

COMPARE the Model 19 with *any* tube checker—you need the features listed below in the instrument you purchase. Try the SUPREME Model 19 and you will have no other.

Model 19 Features

PENTODE TUBE TESTS
Tests Overhead Filament Type Tubes
Plate Current Reading
Grid Tests on all Amplifiers
Pin Jacks Insulated
Accurate Plate Current and Grid Tests Limits on Panel
All Tubes Tested with Rated Filament Potential

2-Volt Tube Tests
Tests Both Plates, '80 Type Tubes without Adapters
Screen Grid Operating Tests
Available with Detachable Portable Cover
Full Size Transformer
All Tube Circuits isolated from Power Supply Circuit
Both Meter Scales Accurately Calibrated
Full 3½" D'Arsonval Type Meter

Your Guarantee

"Satisfaction is Guaranteed." In brief, if after investing in a SUPREME Model 19 Tube Checker you do not feel that you have obtained the maximum value in this type of instrument—if it fails to prove "Supreme by Comparison," return it within 10 days from receipt thereof, transportation charges prepaid, and GET YOUR MONEY BACK. We make this offer based on our confidence in *Your* judgment and the quality of *Our* product. Mail the order blank below at once—*You can't lose.*

SUPREME INSTRUMENTS CORP.
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☐ Counter Type, Dealers Net Price, F.O.B. Greenwood, Miss. $26.95

☐ Portable Type, Dealers Net Price, F.O.B. Greenwood, Miss. $29.95

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Craftsmen's Letters

(*Continued from page* 39)

"low" spot of another, or vice versa. This makes the low-frequency type of superheterodyne more of a nuisance than a practical receiver, especially in localities where there are numerous broadcast stations; and these disadvantages outweigh the benefits to be expected from its high amplification possibilities.

On the other hand, by using an intermediate frequency sufficiently high, say about 475 kc., stations will be received at only one point on the oscillator dial, and heterodyne squeals are eliminated. However, the intermediate amplifier is working at almost as high a frequency as if the stations were being tuned in direct, as in the case of a tuned radio-frequency receiver; and the amplification is therefore not much better than could be obtained from a tuned radio-frequency set.

In order to retain the advantages of both the high-frequency and the low-frequency amplifiers and, at the same time, eliminate their disadvantages, I submit the following plan with reference to the accompanying sketch:

Let there be two separate intermediate amplifiers; the first of which is of the high-frequency type and the second of the low-frequency type. There will then be only one spot on the first-oscillator dial for any station and the output of the second detector will always be at the same frequency, for all stations. Mix the output of the second detector with that of a second oscillator, and pass the resultant difference in frequency through a low-frequency amplifier. The second oscillator, once properly "tuned in" between the second detector and the low-frequency amplifier, will require no further tuning.

An arrangement such as that shown in the accompanying sketch would require a total of nine tuned stages; seven of which are fixed in tune and only two need to be "tuned in" in operation.

I must admit that I have not tried out this plan in practice, and no doubt some difficulties would arise, as they do in almost all experimental circuits. But, if you think an arrangement such as this is worth experimenting on, I shall be glad to have you publish this letter; as it may be of interest to other experimenters.

COLEMAN SUTTON.
319 *West Grand Ave., Alhambra, Cal.*

(Our correspondent's suggestion will be of interest to many experimenters, who wish to try their ingenuity on something different. With the parts of one of the old superheterodynes—such as the Radiola 25, which has an intermediate frequency of 45 k.c.—preceded by a high-frequency I.F. amplifier, of the kind which several constructors have lately described, very high and very selective amplification might be obtained. To put band-pass filters ahead of the first stage of a receiver lowers sensitivity and the possibility of extreme distant reception; while indiscriminate amplification of all signals causes cross-modulation in presence of strong local interference. A similar idea has been employed in transoceanic commercial communication for some years.—*Editor.*)

MISCALLING TECHNICALITIES

Editor, RADIO-CRAFT:

The miniature edition of the February issue of RADIO-CRAFT, of which I recently

A new radio thrill for you! Listen in DIRECT to London, Paris, Berlin, Buenos Aires and other broadcasting stations throughout the world via short waves. Enjoy unique foreign programs from strange lands. Your ordinary receiver cannot tune in these low wave stations. WORLD-WIDE RECEIVER gets 14 to 550 meter stations with surprising clarity. **SEND NO MONEY!** Just write your name and address on a postcard and ask us to send you this wonderful guaranteed short wave set. Pay postman $6.45 plus a small delivery charge. All orders West of the Rockies must be accompanied by $1.00 deposit. Price in foreign countries, $7.75 delivered. Order today!

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AC—A B C Power Packs, completely assembled..... 8.75
Tubes: UX type, 30-day replacement guarantee, No. 210, $2.25; No. 250, $2.45; No. 281, $1.85; No. 245, $1.25; No. 224, $1.25; No. 227, 75c; No. 226, 65c; No. 171, 75c.
International Microphone, two button for public address system and transmitters, speech or music.....$9.75

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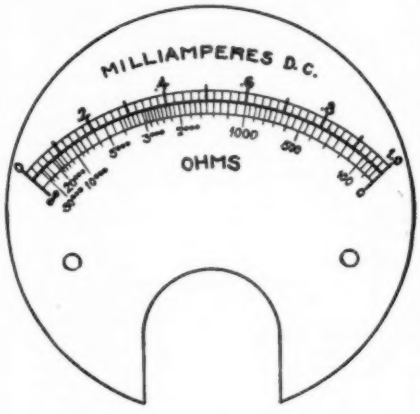
received a copy, is very interesting. However, on looking over the book, I find a very bad error on page 480 (Fig. 2) in Mr. Bernd's kink of using a ruling pen to handle small nuts. The illustration shows a pair of dividers instead.

Being a draftsman of long experience, I don't like having the dear public misled about the working tools of our profession.

KARL H. SEEBERS,

(On consulting our chief draftsman, Mr. T. Pentz, we learn that this criticism is just, from an artistic standpoint. Mr. Bernd sent a description of the use of a ruling pen with an illustration of a pair of dividers, which was reproduced on page 481, of the issue referred to. Either tool, however, might be used as described; and the pen would in many cases be more useful, giving a longer reach. Incidentally, this is a testimonial to the readability of this miniature edition; of which a few copies remain which we shall be glad to send to the first inquiring readers.—*Editor.*)



THE HARD-TO-SELL RADIO SET

By M. N. Leibowitz.

NO other industry has achieved the standardization of the radio industry in products as intricate as radio sets. The only variety is in the cabinet's design or general appearance.

Several large radio retailers in New York City have hit upon an ingenious and inexpensive means of individualizing the hard-to-sell radio set. Such a set is provided with an automatic line-voltage regulator, which is nothing more than a socket and a suitable Amperite inserted in the connecting cord and screwed inside the cabinet. (The cost is about $1.75.) The salesman, after pointing out the standard features of the set in question, climaxes his sales talk by calling attention to the additional feature—"and in addition to all these features," he explains to the hesitant buyer, "there is a unique and indispensable feature, the automatic line-voltage regulator, which you see back here. It insures uniform, positive, satisfactory operation at all times, and saves you untold money in longer tube life and diminished servicing costs." That generally clinches the sale and moves the hard-to-sell set.

Milliammeter into Ohmmeter

(*Continued from page* 16)

The scale reproduced corresponds to those of the Weston "301" and Jewell "88" milliammeters (which differ in the positions of the screwholes). Corresponding resistance readings may be entered on any milliampere scale.

the expected accuracy. Unless precision resistors are employed, the conversion of milliammeter and voltmeter instruments for a multiplicity of purposes is a sheer waste of time.

Short-Wave Receiver-Adapter

(*Continued from page* 35)

angles and as far from detracting influences as the location permits. If but one aerial is used, the operator may mount a small S.P.D.T. switch on the back of the tuner's cabinet. The same ground is used, providing it is satisfactory for use on the short waves.

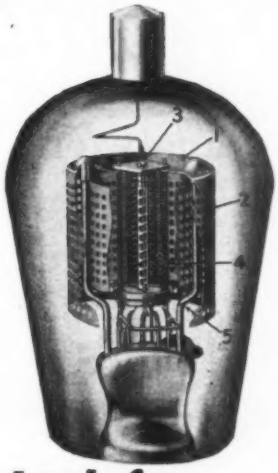
Parts Used

C1, C2—2 National S.W. condensers, "Type S.E." 125 mmf.;
C3—National equicycle condenser, 250 mmf.;
C4—Polymet molded fixed condenser, 150 mmf.;
C5, C6, C7, C10, C11—Polymet molded fixed condensers, .01 mf.;
C8—1-mf. by-pass condenser;
C9—2-mf. by-pass condenser;
C12—X-L Vario-Denser, "Type N";
R1—2000-ohm fixed resistor;
R2—2-meg. grid leak;
R3—500-ohm fixed resistor;
R4—3-meg. grid leak;
R5—Clarostat volume control;
R6—Centralab Radiohm, 500,000 ohms;
R7—1800-ohm resistor, preferably variable;
R8—Clarostat "Hum-Dinger" hum balancer, 20 ohms;
AT—Silver-Marshall audio transformer, "Type 225" or "255";
AFC—Audio filter choke, 80-henry;
FT—Filament transformer, 2½ volts, 6 amperes;
JS—Yaxley jack switch, "Type 45";
RFC—Hammarlund shielded, polarized S.W. choke;
L1, L2—6 Pilot or Silver-Marshall UY coil forms;
Four Pilot UY sockets; one Eby UY wafer socket;
One aluminum double can, 8¾ x 7¾ x 5¾ inches;
7 x 18-inch metal panel; 9 x 17½-inch metal subpanel;
Four-wire cable, hook-up wire, hardware, etc.

A very effective resistor, for R3, may be one of the windings from a discarded pair of head phones. If the ends of the coil are carefully soldered, an absolutely silent and permanent resistance will result.

The layout of the front panel is left somewhat to the choice of the builder. Two vernier dials may be used for the tuning controls; a more balanced appearance will result, however, if a very small vernier condenser is placed above C1 (in the respective

IT'S EASY TO IDENTIFY 1931 TUBES



Look for Clean-Cut Screen-Grids

Minimum metal for maximum electrical and mechanical strength—that is the true test of a screen-grid tube. De Forest engineers have attained those prerequisites by

1. Plate instead of mesh for greater degassification, increased strength and closer tolerances.
2. Perforations to decrease possible secondary emission.
3. Patented De Forest notched cathode insulator for practical quick-heater performance.
4. Molybdenum wire for both grids, costing 20 times as much as nickel. Higher melting point permits greater degassification.
5. Continuous support for outside screen, insuring maximum rigidity.

de Forest AUDIONS RADIO TUBES

DE FOREST RADIO CO.
PASSAIC, N. J.

. . . . set testing reduced to *Simplicity* with the New Readrite analyzers

ACHIEVEMENT in perfecting and simplifying testing equipment for servicemen, dealers and experimenters is still of prime importance—and for the past twenty-seven years Readrite engineers have periodically placed on the market testing equipment of advanced design. Good testing equipment today is *indispensable*—and for rapid adjustments, expert servicing and testing. Readrite products are increasingly being demanded. Investigate the advantages of using Readrite equipment—the products that have been sold for over a quarter of a century.

Model 700

THE MODEL 700 Meter is equipped with a practical selector switch for checking all parts of the tube circuits by connecting to the set sockets. Selection for testing voltages of plate, grid, cathode and screen-grid is done quickly and accurately. Plate current, filament volts, also line and power supply volts are measured. The grid swing test for tubes is used. Just push one button for screen-grid and another button for other tubes. Makes testing of all type tubes simple and thorough. A 4½ volt grid battery is furnished. The battery is used for the grid test and also continuity testing of transformers, chokes, etc. Capacity and resistance charts are furnished showing the use of instruments for testing condensers, also measuring resistances up to 100,000 ohms. The eight scale readings of the meters may be used separately with jack terminals provided. The scale readings are 0-60-300-600 D. C. volts, 0-10-140-700 A. C. volts and 0-20-100 milliamperes. Both A. C. and D. C. filament voltages are accurately measured on one meter.

This model is housed in a strong case with leatherette covering; it is attractive and compact, as well as complete. Cover is removable. It fills every need for the expert serviceman or the beginner for radio set analyzing. Size 10¾ x 3½ x 8 inches.

No. 700 - - - - List Price $25.00

MODEL 600

contains exactly the same testing equipment as No. 700 but the carrying case is much larger and is equipped with a lock. Room is provided for carrying tubes, tools and supplies. The test equipment and panel is in a removable tray in the top of the case. The tray may be used separately as a complete test panel for shop purposes. Size 14½ x 7 x 7½ inches.

No. 600 - - - - List Price $30.00

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positions of C3 and R6) and plain knobs are used. This construction will also make for quicker tuning, it being difficult to turn a high-ratio vernier with the left hand as quickly as with the right. The jack switch may go beneath the dial of C2.

It has been found best to use a filament transformer which comprises an electrostatic shield. By this means, a noticeable improvement in the operation of the tuner is effected; the shield grounding many of the A.C. line noises, which otherwise might prove exceedingly annoying. Should such a transformer be difficult to obtain, a transformer of the proper size may often be readily taken apart and a shield added. This is done by placing around the primary winding a sheet of soft iron as wide as the core permits. Care should be taken to insulate the overlapping ends of the shield from each other, to prevent a possible short of the single turn. A lead several inches long should be soldered to the shield before giving it a layer of tape and replacing the secondary.

The coils are wound on standard UY coil forms, 1½ inches in diameter, with No. 24 D.S.C wire. The grid winding is at the top in each case, with the tickler ⅛-inch or the primary ½-inch below. Beginning at the top of the form, leads are taken off as follows: Grid, "F" (Gnd.); F (to "B" supply) Plate; and, for the primary of L1, "F" (Gnd.), "C" (Ant.).

	Turns L1		Turns L2	
Meters	(Grid.)	(Pri.)	(Grid.)	(Tick.)
18.5-32.....	6½	5	4¾	5½
31.5-52.....	9½	6	8¾	6½
50.0-85.....	18½	7	17½	8½

RAFTERS, BOLTS AND NUTS

By John Hardt

THE idea I am about to describe has served me lots of times and I am sure it will be of interest to many others. It is illustrated below.

This is a space-saving idea; but be sure to screw the jar up tight.

Every mechanic has his choice collection of bolts, nuts and washers; which often are carefully filed in lettered boxes, or in cans, but still more often, are not filed at all! But how handy it is for anyone to reach overhead, unscrew a glass bottle from its threaded cap, select the desired part, and replace the bottle by a turn of the wrist.

This arrangement is the result of fastening the metal cover to an overhead rafter by means of a couple of screws. A number of these present a neat appearance, and are very handy. (If the rafters are low, "watch your head!")

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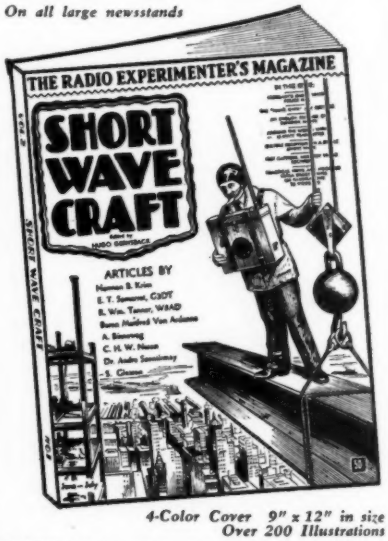

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Improving Short-Wave Reception

(*Continued from page 37*)

an ordinary short-wave receiver is considerably less than that of an ordinary broadcast set.

The superheterodyne overcomes, to some extent, the difficulties mentioned; but it is, as usual, more complicated in comparison.

Constructional Suggestions

There are various refinements in short-wave receivers on which the experimenter can work, but they are not practical for manufactured receivers. A manufactured receiver is a compromise reached by the design engineers, taking into consideration many conflicting factors. However, an experimenter is not limited in any way, perhaps, other than by the contents of his pocketbook. For instance, to increase the amplification of short-wave sets without, at the same time, increasing unduly the number of tuning controls, a screen-grid tube may be used for a detector. Experimenters who have worked with screen-grid detectors, on short-waves, report that the single detector tube gives results equal to those of an ordinary detector tube and one stage of audio amplification. The circuit of a screen-grid detector is shown in Fig. 7.

Ordinary short-wave adapters are not very sensitive; one possibility of increasing the sensitivity is to use a screen-grid tube in the adapter itself. The reason, perhaps, why these tubes have not been used to a greater extent in adapters, is that a slight complication results because an extra voltage tap is required for the screen-grid terminal on the tube. However, this should not be difficult to overcome.

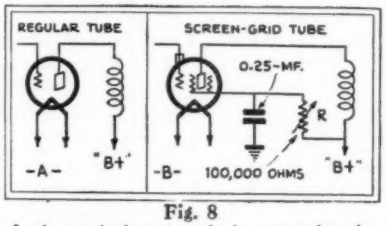

Fig. 8

In the usual adapter, a tube is connected to the detector socket through two or more leads. Ingenuity may be needed to use a screen-grid tube as the S.-W. detector.

One method would be to connect a resistor (R, Fig. 8B) of suitable value, to the plate lead; thus reducing the voltage sufficiently for the screen-grid. This resistor should, preferably, be variable; because individual screen-grid tubes vary considerably in their characteristics.

Another way to increase the sensitivity of the ordinary short-wave receiver, or adapter, is to add a stage of R.F. amplification ahead of it. There are two types of R.F. amplifiers which are ordinarily employed. In one, the input is *untuned;* a choke or a resistor of suitable value being connected across the input to the R.F. stage. However, this type of circuit arrangement gives only low amplification. By using a *tuned* stage of amplification ahead of the detector, a considerable increase in signal strength will result. A circuit diagram of such a single-stage R.F. amplifier is shown in Fig. 9. Its addition to an ordinary short-wave receiver or adapter is not difficult.

The combination of a stage of screen-grid R.F. amplification and a screen-grid detector is quite sensitive, and will give very good results, when compared to the ordinary short-wave arrangement. It must be remembered, however, that *a screen-grid tube has a high plate impedance and,* for this reason, *it must have a high value of plate inductance* (*L2*). This may be an ordinary short-wave choke coil of good design, *provided* the constructor couples the winding of the choke-coil L2 inductively to coil L3 of the detector (Fig. 9). If this cannot be done, the choke cannot be used.

Instead of the choke, a winding of about 200 turns of No. 36 wire on a piece of one-inch tubing may be used. This coil (L2, Fig. 9) should be closely coupled to L3, the secondary coil of the detector.

The dotted lines in Fig. 9 show an alternative arrangement in which a small coupling condenser of .0002-mf. capacity is used to couple the R.F. amplifier to the detector. In this case, L2 and L3 need not be coupled inductively, and L2 may be any available *short-wave* R.F. choke coil.

The experimenter may desire to increase the amplification still more. (It is not desirable to do so, unless tuned stages are used; untuned stages are poor amplifiers, and usually not worth adding.) The addition of more tuned stages means more controls, but the signal strength, especially on foreign stations is greatly increased; so that the additional controls may be well worth while. Each of the stages of R.F. may take the form of either of the two arrangements suggested in Fig. 9. Each grid circuit is tuned; and each plate circuit is coupled, to the grid circuit of the next tube, either inductively or capacitatively coupled (through a condenser of about .0002-mf.) The signal strength obtained with *two* stages of R.F. amplification ahead of the detector is very good.

(Do not make the mistake, as many experimenters do, of purchasing low-grade screen-grid tubes, they will not give good results at short wavelengths.)

Options in Design

The tuning condensers of the R.F. stages should not be larger than .00035-mf. in capacity and, *preferably, much smaller.* The amplification of an R.F. stage falls off quickly as the value of the tuning capacity is increased beyond a certain value.

If one desires to receive some particular foreign stations, small midget condensers can be used for tuning and correspondingly larger inductance coils. This will result in greatest amplification at the desired frequency. (See page 29, July, 1930 RADIO-CRAFT, "Spreading Short-Wave Stations on the Dial.")

With small condensers, more plug-in coils are, of course, necessary. Large condensers require a smaller number of coils, but give less amplification from the stage. The experimenter should choose between these extremes; it would seem, however, better to get fine results on a few stations than to obtain poor results on a large number. This is the failing of many short-wave receivers. The designers have been too ambitious to cover the largest possible ranges; with the result that the amplification has suffered

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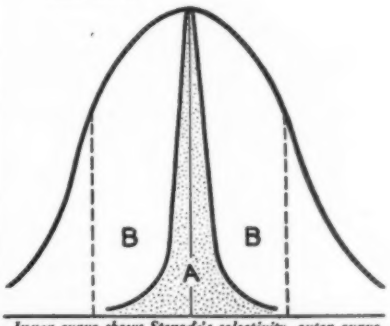

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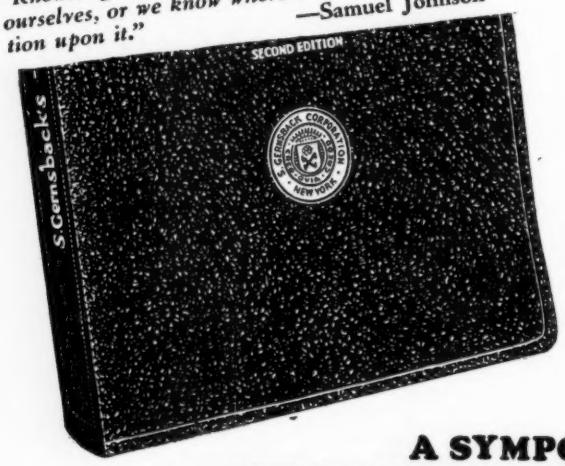

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greatly, and personal satisfaction to the user, in proportion.

Many plug-in coils are troublesome, but necessary if a wide tuning range and good amplification are desired, *at lowest expense*, (and without recourse to complicated switches).

In any short-wave set the coils, if unshielded, should not be greater than two inches in diameter. Good broadcast coils, having low losses, and unshielded, are often three inches in diameter. It is important, for short-waves to wind good space-wound coils; the increase in amplification will be quite noticeable. (See Fig. 1.)

If a breadboard layout is constructed, give all parts plenty of spacing. Often, by so doing, the shielding can be dispensed with (depending upon parts used, local station power, and other factors). Otherwise, ample room in the shield cans.

If the experimenter or set builder will take into consideration, when designing his short-wave receiver, the foregoing principles, he cannot help but increase greatly his enjoyment of long-distance, short-wave programs originating in many foreign lands.

Figuring R. F. Coils

(*Continued from page* 37)

A handy, and quite accurate, formula for the calculation of the inductance of a simple single-layer coil is as follows:

$$L = \frac{0.2\, d^2\, N^2}{3d + 9b}$$

Those not familiar with equations of this kind will understand its application more readily as expressed below:

Multiply the number of turns of wire by the diameter of the form (in inches): square the product, and divide by 5. Then add three times the diameter of the form to nine times its length (also in inches). Divide the result of the first operation by that of the second; the result is the inductance of the coil in *microhenries*. (A number is *squared* when multiplied by itself; the square of 4, for instance, is 16.)

For example: A cylinder with a diameter of 2 inches has 70 turns of wire wound on it, and the length of the winding is 2 inches. Substituting these values in the above formula, we have:

$$\frac{0.2 \times 2 \times 2 \times 70 \times 70}{(3 \times 2) + (9 \times 2)} = 163.3 \text{ mh.}$$

The use of the L×C table simplifies the amount of work necessary to determine the various values of L and C required for the broadcast band.

For example: A .0005-mf. variable condenser is available, and it is desired to find the value of inductance which will enable the combination to tune to the *highest wavelength in* the broadcast band.

Referring to Table I, we find that the product of L and C corresponding to 545.1 meters (or 550 kc.) on the chart is .08428. Dividing this number by .0005 (the capacity of the condenser in microfarads) we obtain 168.6, the inductance of the coil in microhenries.

Now, in order that the combination of the coil and condenser shall tune from the highest to the lowest wavelength, it becomes

TABLE I

Kc.	WL.	LxC	Kc.	WL.	LxC
550	545.1	.08428	1030	291.1	0.2389
560	535.4	.08119	1040	288.3	.02343
570	526.0	.07827	1050	285.5	.02299
580	516.9	.07551	1060	282.8	.02255
590	508.2	.07288	1070	280.2	.02213
600	499.7	.07040	1080	277.6	.02171
610	491.5	.06808	1090	275.1	.02130
620	483.6	.06593	1100	272.6	.02090
630	475.9	.06383	1110	270.1	.02052
640	468.5	.06185	1120	267.7	.02016
650	461.3	.05998	1130	265.3	.01980
660	454.3	.05823	1140	263.0	.01946
670	447.5	.05658	1150	260.7	.01914
680	440.9	.05501	1160	258.5	.01882
690	434.5	.05348	1170	256.3	.01852
700	428.3	.05198	1180	254.1	.01821
710	422.3	.05051	1190	252.0	.01789
720	416.4	.04907	1200	249.9	.01760
730	410.7	.04767	1210	247.8	.01731
740	405.2	.04630	1220	245.8	.01702
750	399.8	.04495	1230	243.8	.01675
760	394.5	.04380	1240	241.8	.01648
770	389.4	.04268	1250	239.9	.01622
780	384.4	.04164	1260	238.0	.01596
790	379.5	.04060	1270	236.1	.01571
800	374.8	.03960	1280	234.2	.01546
810	370.2	.03866	1290	232.4	.01522
820	365.6	.03774	1300	230.6	.01499
830	361.2	.03684	1310	228.9	.01476
840	356.9	.03596	1320	227.1	.01452
850	352.7	.03511	1330	225.4	.01432
860	348.6	.03429	1340	223.7	.01411
870	344.6	.03351	1350	222.1	.01390
880	340.7	.03275	1360	220.4	.01370
890	336.9	.03201	1370	218.8	.01350
900	333.1	.03129	1380	217.3	.01330
910	329.5	.03059	1390	215.7	.01311
920	325.9	.02991	1400	214.2	.01292
930	322.4	.02926	1410	212.6	.01274
940	319.0	.02864	1420	211.1	.01256
950	315.6	.02804	1430	209.7	.01239
960	312.3	.02746	1440	208.2	.01222
970	309.1	.02688	1450	206.8	.01205
980	305.9	.02634	1460	205.4	.01189
990	302.8	.02582	1470	204.0	.01173
1000	299.8	.02532	1480	202.6	.01157
1010	296.9	.02483	1490	201.2	.01142
1020	293.9	.02436	1500	199.9	.01127

necessary to know the *minimum* capacity of the condenser and its associated circuits.

The table is again consulted and the value of the L×C product for 199.9 meters (1500 kc.) is found to be .01127. Substituting this in the formula:

$$\frac{.01127}{168.6 \text{ (mh.)}} = .000067 \text{ (mf.)}$$

As the capacitative effects of the tubes, wiring and shielding, and the minimum capacity of the condenser add together, it can be seen that the actual minimum capacity of the variable condenser alone should be quite small. In practice, 18 mmf. or less is possible.

Thus we find that a coil suitable for use over the broadcast range with a .0005-mf. tuning condenser should have an inductance of approximately 160 to 170 microhenries; the exact value depending upon the actual maximum capacity of the condenser. Most ".0005-mf." variable condensers are not exactly .0005-mf., but slightly over or under that value, unless made with special precision.

Those not interested in the above simple mathematics of the coils will find in Tables II and III some tabulated data of various coil sizes to be used with the more standard values of capacity; namely, .0005- and .00035-microfarad.

In tabulating these coils, the largest size of wire possible, in proportion to the length of winding, is specified.

The various coverings on wires are not of absolutely standard thickness, in one make of wire as compared to another; and, since this table is for shop or experimental use it is advisable to wind more turns than specified here, to compensate for any discrepancy in the maximum value of the condenser, and for difference in the thickness of the insulation. The additional turns are removed after testing the coil in conjunction with the condenser for which it is intended.

The first column of the tables represents the diameter of the coil form, in inches; and the second, the length of the winding in inches. No attempt has been made to maintain the ratio of 2.46 to 1 between diameter and length; which is, theoretically at least, the most efficient in obtaining a given inductance with the least wire.

TABLE II

Coils for .0005-mf. Condensers

Diam. In.	*Length In.*	*Wire*	*No. Turns*
3	1	23 Enam.	42
3	1½	20 Enam.	45
3	2	19 S.C.C.	49
3	2½	18 S.C.C.	55
3	3	16 Enam.	57
2½	1	25 D.S.C.	46
2½	1½	22 Enam.	56
2½	2	20 Enam.	60
2½	2½	19 Enam.	61
2½	3	18 S.C.C.	66
2	1	25 Enam.	53
2	1½	23 Enam.	62
2	2	22 S.C.C.	70
2	2½	20 Enam.	75
2	3	19 Enam.	80
1½	1	28 Enam.	75
1½	1½	26 Enam.	86
1½	2	24 Enam.	94
1½	2½	23 Enam.	100
1½	3	22 Enam.	108
1	1	30 Enam.	95
1	1¼	32 D.S.C.	106
1	1½	28 Enam.	112
1	2	28 D.S.C.	132
1	2½	26 Enam.	140
1	3	25 Enam.	156

TABLE III

Coils for .00035-mf. Condensers

Diam. In.	*Length In.*	*Wire*	*No. Turns*
3	1	26 S.C.C.	50
3	1½	24 D.S.C.	61
3	2	21 S.C.C.	60
3	2½	19 Enam.	65
3	3	18 D.S.C.	68
2½	1	27 D.S.C.	55
2½	1½	24 D.S.C.	53
2½	2	22 D.S.C.	69
2½	2½	21 S.C.C.	75
2½	3	19 Enam.	80
2	1	29 D.S.C.	66
2	1½	26 S.C.C.	75
2	2	24 D.S.C.	89
2	2½	22 Enam.	92
2	3	21 Enam.	99
1½	1	32 D.S.C.	84
1½	1½	27 Enam.	97
1½	2	25 Enam.	104
1½	2½	24 Enam.	115
1½	3	24 S.C.C.	123
1	1	37 D.S.C.	121
1	1¼	35 D.S.C.	132
1	1½	30 Enam.	136
1	2	32 S.C.C.	168
1	2½	29 S.C.C.	165
1	3	28 S.C.C.	180

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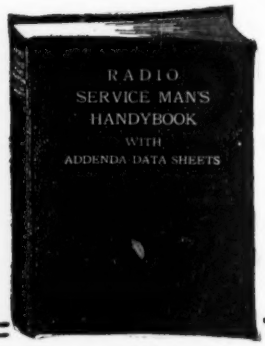

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AS a rather bright and promising corollary to the business depression, through which we have been passing in the radio industry, comes a prophecy from the radio engineers and scientists concerned with the present unusual effect of "sun spots" upon radio reception. This prophecy is already making itself manifest in actuality and shows a silver lining to the clouds which have darkened the sky for the radio industry.

The financial statisticians have shown us rather conclusively that periods of business prosperity and depression have followed one another in a regular cyclical order. Experience has shown them that about 10 or 11 years elapse between successive depths of business depression.

The astronomers tell us that the number of sun spots also passes through a similar cycle and, strangely enough, this cycle is of about the same period. The fact has been recently recognized that, when the number of sun spots reaches its minimum, radio reception conditions become exceptionally good. This is due to the fact that magnetic storms which cause severe variations in radio conditions are also at the minimum and the height of the hypothetic Kennelly-Heaviside layer, which reflects back radio waves to the earth, is also at its minimum; which provides the greatest intensity of signals over the distance usually encountered in radio broadcasting. Those of the radio industry who can recall the Winters of 1920 and 1921 can verify the fact that, during that period, radio reception was excellent.

It is well known to scientists that the great radio reflecting plane a hundred miles above the earth's surface (which is called the Heaviside-Kennelly layer) has been falling steadily for several years, and that this has changed the transmission constants of radio waves. Prominent engineers have estimated that radio reception conditions during the past season have been from two to four times as good as a year ago. Dr. H. T. Stetson, the great astronomer who has been measuring radio reception as a function of solar phenomena, reports the strongest signals in years. It is predicted that reception will probably get better in 1932 and the spring of 1933.

* *President Radio Manufacturers Association.*

Reactance and Impedance

(*Continued from page* 38)

condition in which the voltage across the total circuit is zero and *theoretically* infinite across each element. The presence of resistance lessens this effect, but does not prevent its use in radio circuits. For example, we may design an amplifier stage (such as that shown in Fig. 8) and have the voltage across the inductance L rise to an extremely high value at the resonant point. This allows us to obtain in an A.F. amplifier a bass response which compensates for the lack of "lows" in reproducers, transformers, etc.

In *parallel circuits*, having single inductive and capacitative arms, the voltage across the circuit is the same for each branch; while the *current* through either branch is determined by its reactance. At resonance in a parallel circuit the impedance of the circuit as a whole is theoretically infinite; the current will be zero; and the voltage will attain a maximum value which is limited only by the presence of resistance in the circuit. That is why we attempt to maintain the resistance in radio circuits at a low value.

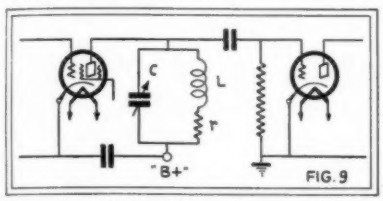

FIG. 9

The tuned circuit C-L would present infinite R.F. impedance at its resonant frequency, except for its innate ohmic resistance.

The impedance of a parallel circuit is the same as that of a series circuit at all other frequencies than that at which resonance occurs. At resonance, the "effective resistance" of a tuned parallel circuit would theoretically become infinite; actually, the effect of the unavoidable ohmic (or pure) resistance in the circuit moderates the effect so that the effective resistance becomes equal to

$$\frac{2\pi \times f \times L)^2}{R}$$

For example, if we desire to know the load presented to a vacuum tube by the resonant circuit shown in Fig. 9—in which the coil has an inductance of 200 microhenries (.0002-henry) and a resistance of 12 ohms at 1,000,000 cycles—we may readily find the effective resistance of the circuit when tuned to resonate at that frequency, which corresponds to 300 meters:

$$R \text{ (effective)} = \frac{6.28 \times 1{,}000{,}000 \times .0002^2}{12} = 131{,}000 \text{ ohms}$$

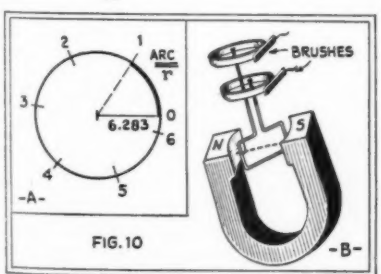

FIG. 10

Left, the heavy arc is a radian; impedance formulas take frequencies, not in whole cycles, but in radians: Right, why a generator creates a sine-wave in its revolution.

NOTE: The presence of the number 6.283+ (2 "pi") in the reactance formulas is accounted for by the fact that in higher mathematics it is found more convenient at times to measure angles in *radians*. The radian is the angle whose arc is just as long as the radius; there are therefore 6.283+ radians in 360 degrees (Fig. 10A). The frequency multiplied by 6.283+, to convert cycles of 360 degrees into radians, is commonly represented in formulas by the Greek letter "omega," which is like a w and is often used also for ohms.

In the sine wave of Fig. 1C, the *slope* of the

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UY-227	.30	201A—Special radio frequency	.60	UX-250	.85
UX-171A	.30	171 Special A.C. ½ amp. extra coated filament	.60	All bakelite shield tube 201A	1.00
UX-171	.30	T-14 (201A High Mu high emission	.60	Ballast tube type D. and M. to prevent tubes from blowing out	1.00
UX-240	.40	Switch tube, 201A or 112 or 171 double life	.60	UX-222—Screen grid radio frequency amplifier	1.10
UX-120	.40	Adapter tube 226, 227, 171A, to convert battery sets into A.C.	.60	UX-247—Pentode	.85
UX-199	.40	WD-11	.60	UX-235	.85
UV-199	.40	WD-12	.60	Tellon television tube	3.85
UV-199 Short prongs	.40	UX-230	.60	Photoelectric cell, 2-inch	3.85
UX-112	.40	UX-231	.60		
UX-112A	.40				
UX-200A	.40				
UY-224	.40				
UX-245	.40				

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—NICK KENNY, Radio Editor, *Mirror.*

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curve represents the rate of change. It is therefore least at the top and bottom, where it is theoretically level; and greatest at the zero points, where it equals 6.283 x *f* x I (maximum); from which the maximum induced potential is found to be 6.283 x *f* x L x I (maximum). Since the factor determining the effective value, as regards the maximum, is the same for both current and voltage, it may be disregarded here.

The reason for the sine-wave form of generated voltages, in general cases, may be seen by considering a coil of wire, in the armature of a generator, revolving in the magnetic field (Fig. 10B). The voltage generated in that coil is proportional to the sine of its angle with the position of greatest flux; and its maximum at right angles, from which as unity (sine 1) the ratio is computed. The generation of a sine wave in an oscillating circuit is a matter of more complexity.

The resonance formulas are all based fundamentally on

$$f = \frac{1}{2\pi\sqrt{L \times C}}$$

in which L is in henries, and C is in farads. To reduce this to more practical units, every time a unit under the square root sign is reduced a million times, the *numerator* is increased a thousand times. When L is in microhenries, and C in micromicrofarads, for radio frequencies::

$$f = \frac{159{,}200 \text{ Kc.}}{\sqrt{L \times C}}$$

The standard work on this subject, for those who wish to go into it with considerable thoroughness, is Circular No. 74 of the Bureau of Standards, "Radio Instruments and Measurements." In this and other issues of RADIO-CRAFT, the matter of resonance and coil design will be treated in a more simple manner, with practical tables of information.—*Editor.*

Book Reviews

S. GERNSBACK'S RADIO ENCYCLOPEDIA (Second Edition). 352 pp., 9 x 12 in. loose-leaf red leatherette binding. Published by S. Gernsback Corporation, New York City, Price $3.98.

This volume, when placed beside its thinner predecessor the *First Edition*, which was the first Radio Encyclopedia published, bears witness to the rapid development, during the past five years, of the most-rapidly growing art. Its appearance has been impatiently waited by many who will appreciate, on seeing it, how much time has been bestowed upon its production, as well as expense, and what efforts have been made to revise its contents up to the very moment when the last pages were committed to the press.

The book contains over 2,200 definitions and, since it is an encyclopedia rather than a dictionary, many of them are of considerable length. *Television*, for instance, covers 8 pages; *Short Wave*, with its associated headings on short-wave antennas, coils, receivers and transmitters, 10 pages; *Sound Projection*, 6 pages; *Vacuum Tubes* and allied headings, 15½ consecutive pages—all these containing information of the latest date. The original *First Edition* had a very thorough foundation of the principles of radio, and those branches of electricity, physics and chemistry bearing upon them; this matter remains still useful and unchanged, but the remainder of the book has been rewritten and doubled in size, with regard to the more recent *applications* of radio in the light of the growth of broadcasting and of other important developments.

The illustrations number over a thousand; hundreds of them are photographs, which reproduce to especial advantage in the new method used for printing the second edition of the *Radio Encyclopedia*. There are 38 practical tables, charts and maps in the text; and an appendix of 21 pages of data on commercial receivers, their layouts, trademarks, types, etc., which will be especially appreciated by every one who is connected with the radio trade.

In the revision of the *Radio Encyclopedia*, it is obvious that especial care was taken, not merely to make its contents as comprehensive as possible, but also to increase its value to the reader by dealing with every subject from the ground up; *i.e.*,

in such a way that even a person who knows little or nothing of radio will be able to read intelligently. This is facilitated by very elaborate cross-references, and the simple definitions, either under separate headings or where first used in any article, of all words which might prove a stumbling-block to the lay reader. The addition of a short reading guide, in fact, would make of this book a course in radio which the novice might follow to secure a thorough grasp of the theory of the subject and much of its practical details.

In its new and attractive dress, the *Radio Encyclopedia* bears witness to the fact that progress in radio may be expected to continue. It is provided with Extra Data Sheets on which the owner may conveniently index additional material of value, obtained from periodicals or otherwise; and, in later years, it is not impossible that supplementary sheets may be issued. As we have said, its present contents are timely up to the moment of publication. The pages are very readable and easy to consult; and the substantial binding well fits the volume to be, as intended, a tool for daily use and frequent consultation. The radio expert, no less than the radio student, will find it a time-saver and a trustworthy guide.

RADIO - FREQUENCY - MEASUREMENTS; by E. B. Moullin, M.A.; 487 pages, cloth, 6 x 9 inches; 289 illustrations; published by J. B. Lippincott Co., Philadelphia, Pa.

The three years spent in revising and enlarging this intensely interesting work are but an indication of the thought, care, and sincerity of purpose which Mr. Moullin has given to his subject.

The book is written in the style of a laboratory manual and, by virtue of its arrangement, is useful as a handbook or reference guide. To advanced students at universities and technical colleges, the book will be a valuable addition to their libraries and text book collections; because it serves as a connecting link between theory, which is oftimes irksome and hard to correlate, and the reality of practical measurements.

The electrical engineers, who have been working with commercial low frequencies, will find that the certainties of low-frequency practice must be discarded and a new conception of the foundation of their faith brought forth in studying the phenomena of radio frequency.

The work starts with the equations of the electromagnetic field; not a full exposition, but the essential ideas with a well worded description passing then into circuit formulae covering Inductance, Capacity, and Resistance in various combinations of circuits and conditions.

The valve generator receives much attention and is nicely handled with the remaining pages more or less evenly apportioned to the following headings: "Measurements of Potential Difference and Circuits," Resistance, Capacity, Inductance, Antenna Characteristics, Intensity of Radiated Fields, and a miscellaneous section which contains a few extremely interesting descriptions. The author brings within two covers, logically and in good order, the wide ramifications of this fast moving and vitally important field.

C. E. D.

Information Bureau

(*Continued from page* 40)

BAFFLE BOARD SIZES

(126) Mr. Elnard May, East Springfield, Mass.

(Q.) Is there available any ready reference, which will indicate the size of baffle recommended for various cut-off frequencies?

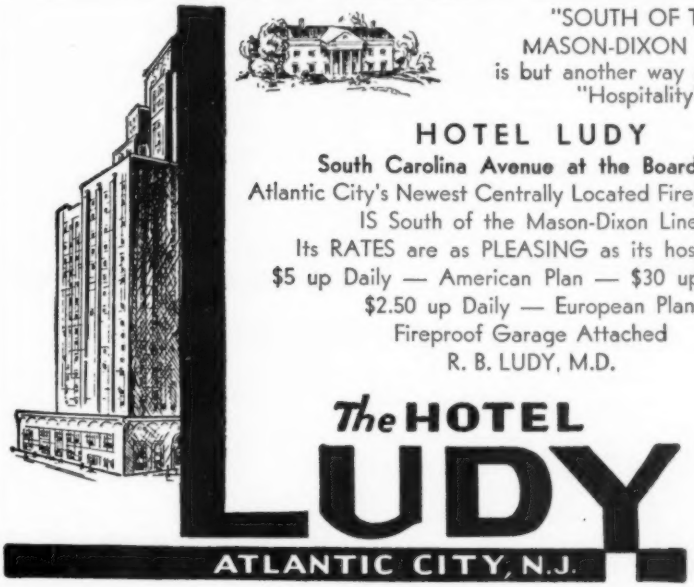
(A.) This information appeared recently in the form of a graph which is reproduced in these columns (Fig. Q.126). It was developed by Mr. A. A. Ghirardi of the Pilot Radio and Tube Company; and appeared in the spring 1931 issue of *Radio Design*.

MAJESTIC "MODEL 70"

(127) Mr. Alfred N. Bacon, New Dorp, S. I., N. Y.

(Q.) What can be the explanation for excessive hum and generally horrible noise in a "Model 70" Majestic receiver? I have tested all resistors for change, all condensers for opens, shorts, and capacity rating, and all voltages appear to be standard. The reproducer diaphragm will move as much as one-quarter inch. There do not seem to be any loose leads in the set and all the tuned circuits appear to be in tune. Have had this experience with several of these receivers.

Hotel Directory of the Radio Trade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BE sure to read the message on page 8 of this issue. It is an important announcement and tells all about the Supplements to the OFFICIAL RADIO SERVICE MANUAL.

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(A.) Loose connections are the usual explanation for this effect; check over the joints once again, using a soldering iron. Defective tubes can cause the same effect or it may be due to loose variable condenser plates. Resistors and condensers will sometimes test okay but develop trouble in service. In this model, changing an A.F. transformer has been known to eliminate the fault.

Check up the centering of the reproducer cone. It may be necessary to float the chassis in the cabinet; using rubber or cork for the insulation. In some instances, the trouble has been cleared by tightening the adjusting screws of the trimmer condensers, and only backing them off slightly (this prevents the movable plates from being set too loose, thereby wobbling and causing the disturbance.)

List of Commercial Circuits Published

(*Continued from page* 16)

September, 1930

Colonial 31 and 32 D.C., 110-volt D.C. Receivers (No. 25 Data Sheet), p. 144;
Fada "Special" Model 265-A and Fada "7" Loop Set Model 475-A (F.A.D. Andrea, Inc.), (No. 26 Data Sheet), p. 145;
U. S. Radio & Telev. Corp. "Model 30" Automotive Receiver, p. 149;
Crosley "Buddy" and "Chum" Receivers, p. 164;

October, 1930

Atwater Kent "Model 40" Power Pack, p. 201;
Majestic "7BP6" Power Pack (similar also to "7P6-7P3," and "7BP3"), p. 201;
Freshman Masterpiece" (early 5-tube model), p. 205;
Kolster K 20, K 22, K 25, K 27 and K 37 6-tube Receivers (No. 27 Data Sheet), p. 206;
Columbia "Screen-Grid 8" Receiver (No. 28 Data Sheet), p. 207;
Radiola "18 D.C." Receiver, 110-volt D.C. circuit, p. 209;
"Stenode" Crystal-Control Receiving Circuit, p. 211;
RCL "Models 5, 10 and 15" Public-Address Adapter Units, p. 218;
Priess "Nine-in-Line" Models R and C Receivers, p. 224.

November, 1930

Radiola-Victor R 80—Westinghouse WR5—Graybar 700—General Electric H-31 A.C. Superheterodynes (No. 29 Data Sheet), p. 268;
Grebe Super-Synchrophase A.C. Receiver Model SK-4 (No. 30 Data Sheet), p. 269;
Brunswick Models "S-14" and "S-21" Receivers, p. 272;
Crosley "Model 54—New Buddy" Midget Set, p. 274;
Jackson-Bell "Model 62" Midget Set, p. 275;
Work-Rite Radio Corp. "Flexi-Unit," p. 275.
Lincoln Radio Corp. "Model 31" Screen-Grid Superheterodyne, p. 276;
Radio Receptor 50-watt "Powerizer Model PXP 245 Driver" and "Model P50W Power Amplifier," p. 289;
Stewart-Warner "Series 950" A.C. Screen-Grid Set, p. 290.

December, 1930

Howard "Model SG-A" Screen-Grid Receiver (No. 31 Data Sheet), p. 332;
All-American Mohawk "Model D" Lyric Receiver (No. 32 Data Sheet), p. 333;
Delco "Police" Short-Wave Receiver, p. 344;
Crosley "Models 5-50" and "5-75" Sets, p. 360;
Crosley "Model 52" Receiver, p. 360.

January, 1931

Victor "Micro-Synchronous" Radio, Models "R-35," "R-39," and "RE-57" (No. 33 Data Sheet), p. 396;
Silver-Marshall Superheterodyne, with "Model 36A" Chassis and "32A" Power Pack (No. 34 Data Sheet), p. 397;
Supreme "Model 90" Set Analyzer, p. 425;
Van Horne-Flewelling "Model D" Tube Checker, p. 426;
Pilot "Midget Set," p. 406;

CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted at the cost of ten cents per word for each insertion—name, initial and address each count as one word. Cash should accompany all classified advertisements unless placed by a recognized advertising agency. No less than ten words are accepted. Advertising for the August issue should be received not later than June 7th.

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Federated Purchaser "Cathedral Tone" Melorad Midget Receiver, p. 406;
Jesse French & Son Piano Co. "Model G, Junior" Midget Set, p. 407;
Master Radio Mfg. Co., Ltd., "Model 424" Midget Receiver, p. 407;
Pierce-Airo, Inc. "DeWald, Model AC-524" Midget Set, p. 408;
Transformer Corp. of America, "Clarion, Jr." Midget Receiver, p. 408;
Remler Division, Gray & Danielson Mfg. Co., "Cameo Model 14" Midget, p. 408;
Keller-Fuller Mfg. Co., Ltd., "Radiette Model 14F" Midget Receiver, p. 408;
Northern Electric Model "R-50" Peanut-Tube Receiver (Resembling the "Everyman Four"), p. 420.

February, 1931

Sparton "Model 301 Equasonne" A.C. Set, p. 459;
Majestic "Models 50," "51," and "52" Midget and Low-Boy Superheterodynes (No. 35 Data Sheet), p. 462;
Kennedy "Model 826B" Combination Long- and Short-Wave Receiver (No. 36 Data Sheet), p. 463;
Silver-Marshall "Sargent-Rayment 710" Receiver and Model "S.M. 675" Power Amplifier, p. 475;
Moore Radio Laboratories Model "Da-Lite R" Screen-Grid R.F. Chassis, p. 478;
Walbert "Penetrola," p. 488;
Knight "8/9 A.C." Set, p. 488.

March, 1931

Philco "Screen-Grid Plus" Receivers, Models 92, 95, 95E, 96, 96A, 96E, 296 and 296 E (Philadelphia Storage Battery Co.), (No. 37 Data Sheet), p. 524;
Brunswick Model B-15 "Uni-Selector" 2-Volt Tube Type Radio Set (No. 38 Data Sheet), p. 525;
Electrad, Inc., Loftin-White "Model C-250" Direct-Coupled Audio Amplifier, p. 534;
Insuline Corp. "Companion" Portable 1-Tube A.C. Set, p. 535;
Hammarlund "Hawk" 2-volt Tube Short-Wave Receiver, p. 541;
"Airex ABC" Eliminator, p. 552.

April, 1931

Erla Model 224 A.C. Screen-Grid Receiver, (Electrical Research Laboratories, Inc.), (No. 39 Data Sheet), p. 590;
Bosch Model 60 (American Bosch Magneto Corp.), (No. 40 Data Sheet), p. 591;
Supreme "Model 19" Single-Meter Tube Checker, p. 593;
All-American Mohawk "Model B-94" Lyric 2-Volt Tube Receiver, p. 595;
Philco "Model 30" 2-volt Tube Set, p. 596;
Lincoln "Model D.C. 8" 2-volt Tube Superheterodyne, p. 597;
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Pilot "Universal Super-Wasp" A.C.-Operated Multi-Wave Receiver, p. 605;
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Silvertone Models "F," "FF," "G," "H," and "J" Radio Sets (Sears, Roebuck & Co. early battery and A.C. receivers), (No. 41 Data Sheet), p. 652;
Radiola "28" Superheterodyne and "104" Power Speaker (No. 42 Data Sheet), p. 653;
"L-32 Ultradyne" Screen-grid, All-Wave Superheterodyne. (Traul Radio Co.), p. 666;
"SWS-9" Short-Wave (and long-wave) Superheterodyne (Wireless Egert Engineering Co.), p. 668;
Radiola "28" Circuit (without power connections), p. 670.

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Zenith Model "11E," p. 716;
Crosley Model 120 ("Super-Sondo," "Super-Rondeau," "Super-Administrator") Senior Superheterodyne (Pliodynatron) Chassis (No. 43 Data Sheet), p. 720;
Westinghouse "Columnaire" Models WR-8 and WR-8-R (Remote Control) (Representative of RCA-Victor Radiola Models R-80, R-82, R-86; Westinghouse Models WR-5, WR-6, WR-6-R, WR-7, WR-7-R; Graybar 700, 770, 900; General Electric H-31, H-51, H-71), (No. 44 Data Sheet), p. 721;
"Air King" Super Converter, p. 734;
Mayolian "B" Eliminators (Models 609, 611, 612, 614 and 615), p. 742;
Silver-Marshall Models 37, 38 and 39 Midget Superheterodynes, p. 759.

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Enclosed find check or money order for $7.50 for Gem Midget Hand Mike.
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Model "C"—9" Chassis with 900 ohm field and output transformer. Can be used with any set employing 1-171A or 1-245 power tube. Also can be used in Majestic Model 71.
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THE SMALLEST
17" x 13" x 7½"
THE LIGHTEST
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THE MIGHTIEST
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on ¼ inch thick, warp-proof, five-ply boards, size 15 x 15, ready to install into cabinet.
These motors are absolutely NOISELESS, of very rugged construction, operate on 110 volt A.C. current, and are equipped with Speed Regulator and 6 foot cord and plug. The 12" turntable will take any standard size record.
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OUTPUT 110-120 Volt, Rated at 150-160 Watt

For use in localities where 220 volt, 60 cycle A.C. current is supplied. These Transformers adapt current of that voltage to any A.C. Radio or other Electrical Appliance which consumes up to 160 watts. Encased and easily mounted.
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Ship'g w't: 6¼ lbs.

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Model D 7 D C 10" Diameter
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These units contain suitable push-pull transformers and are absolutely hum-free. Connect directly to the set, no outside wires.
As most standard manufactured A.C. sets are engineered for D.C. speakers of this ohmage, the possibilities for replacement with this really good speaker are practically unlimited.
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Replacement for defective blocks in "B" Eliminators — identical in electrical characteristics and outside dimensions. Can also be used in any make "B" Eliminator as well as most power packs

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(Genuine R.C.A.)

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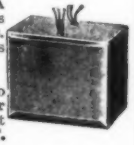
For Model 37 and 38 Sets

Ideal filtering system for ANY make A. C. set using 171-A tube. Contains proper chokes and high voltage condensers. Flexible wire colored leads same as original.

HOOK-UP

Green wire to 280, black to R.F. plate, yellow to Power Tube plate, white to first audio by-pass, white to C.T. of 226 resistance, red to detector plate. Wire from can to ground.



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Magnetic type cone speaker. Remarkable tone quality; volume to spare. Beautifully carved, fine Walnut cabinet. Equipped with highly sensitive oversize magnet and driving unit. Faithful reproduction from the faintest whisper to fullest volume of a brass band.

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Brings in European stations clear as a bell. Converts any set into a short wave receiver. Employs 3-227 tubes; covers from 20 to 115 meters. Coil switch covers all wave lengths. Single dial control, no body capacity, no squeals. Has built-in filament transformer to heat the 3-227's. All you need from your receiver is a positive B. voltage from 45 to 180 volts. Voltage is not critical; no molestation of the receiver. Size 7x10x5 in. Weight 8 lbs.

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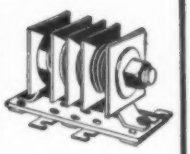
Standard on "A" Eliminators for Majestic, Mayolian, Webster, Elkon, Bernard, Fada, Knapp, Sentinel, Metro, General Instrument, Philco (Elkon equipped) and also on Elkon 3 amp., and Briggs & Stratton chargers.



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This Nathaniel Baldwin unit is one of the finest. For phonograph, automobile and portable radio outfits. We offer this famous unit now at a sensationally reduced price.

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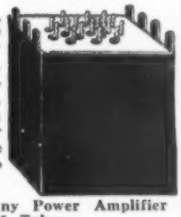
For use with 6-226, 2-245, 1-227 and 1-280 tubes. Magnetically shielded preventing hum. Can safely be overloaded 30%. High voltages, 400 volts at 150 mils on either side of center tap. Extra large case especially designed to prevent overheating.



Can Be Used For Any Power Amplifier Using 245 Tubes

Size: 4½ x 5 x 5½ inches.
No. 1—Center tap of 9 and 14 (5 volts).
No. 2 and 4—2½ Volts.
No. 5 and 7—1 in. V. High amp. (226).
No. 3 and 6—Primary (110V. input).
No. 8—Center tap of 12 and 17 (2½ V.)
No. 9 and 14—5 Volts (280).
No. 10 and 15—High voltage for B supply.
No. 16—Center tap of above.
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Dry Electrolytic Condensers

Mount in any position! Guaranteed never to blow out! Remarkably compact and very inexpensive, permitting generous use of filtering systems. The greater the mfd. capacity employed, the less A.C. hum remains. 500 volt peak rating. Ideal for all 171A - 245 power packs—use two of each capacity desired for 250 power packs (1,000 volt peak thereby assured).

No.	Mfd.	Diameter	Length	YOUR PRICE
1801	1	¾ in.	2½ in.	$0.27
1802	2	1 in.	2⅝ in.	.44
1804	4	1½ in.	2⅛ in.	.83
1808	8	1⅝ in.	4½ in.	1.20
1816	16	3 in.	4¼ in.	2.10
1824	24	3 in.	4¼ in.	2.70
1832	32	3 in.	4¼ in.	3.30
1854	54	3 in.	4½ in.	4.73

THORDARSON "245" Power Transformer

A Miniature Power Plant — Supplies All ABC Voltages — 80 Watts

In addition to supplying a full 250 volts to the plates and 50 volts to the grids of two type '45 tubes in push-pull, this transformer may be used to light the filaments of seven or eight 2.5-volt filament tubes; and by connecting in series two of the three 2.5-volt filament secondaries it is possible to light 5-volt filaments too. Five secondaries: S1—5 V., 2 Amp.; S2—310 V. Cent. T.; S3—2½ V., 3 Amp. Cent. T.; S4—2½ V., 10½ Amp.; S5—2½ V., 3 Amp. Cent. T. **Just the power transformer for building up a high-grade public address amplifier to use a screen-grid A.F. amplifier to boost the output of a microphone or phonograph pick-up;** following this with two stages of push-pull amplification consisting of two '27's in the first stage and two '45's in the second. Bottom of transformer has bakelite panel on which are mounted all taps. **It outperforms ANY similar transformer.** Many Service Men keep this model transformer on hand for emergency replacements in hundreds of makes of radio sets. For 110-120 volts, 50-60 cycles. Size: 5 in. high x 4 x 3½ in. Shipping weight, 8 lbs. **List Price, $15.00.**

No. 1450—Thordarson Power Transformer. YOUR PRICE..... $3.85

Television Receiving Lamps

These Television Receiving Tubes have been designed to avoid high space charges, and at the same time confine the light to the most useful portion of the cathode. Brilliant light spots usually found on the cathode and caused by high frequency current vibrations have been entirely eliminated by a special process which minimizes "sputtering" under the influence of the discharge. Rigid support of the elements is obtained by the use of sturdy glass rods. 1¼ in. x 3½ in. with cathode 1 in. square. Shipping weight, ½ lb.

No. 775—Television Lamp. List Price, $4.00. YOUR PRICE..... $1.98

A.C. Short Wave Converter

The thrill of tuning in short waves is yours, because you can connect this short-wave converter to your broadcast receiver, no matter what type receiver you have. Tunes from 10 to 200 meters, using only two plug-in coils. Coils, already wound, are supplied with outfit. Converter has built-in filament transformer to heat three 227's. All you need obtain from your receiver is a positive "B" voltage, anything from 45 to 180 volts. Voltage not critical. No molestation of the receiver. No tricky regeneration control, only a single, smooth-operating dial to manipulate. No squeals, no grunting, no body capacity. All parts for 3-tube short-wave converter, including cabinet, with filament transformer, complete instructions and pictorial diagram. Shipping weight 8 lbs.

List Price $20.00.

No. 1617—YOUR PRICE, less tubes **$9.45**

NEW READRITE Analyzer

This three-meter analyzer has selector switch for checking all parts of tube circuits by connecting to the set sockets. Selection for testing voltages of plate, grid, cathode and screen-grid done quickly and accurately. Plate current, filament volts, line and power supply volts are measured. Grid swing test for tubes used. Just push one button for screen-grid and other button for other tubes. Makes testing of all type tubes simple and thorough. 4½-volt grid battery is furnished. Battery is used for grid test and continuity testing of transformers, chokes, etc. Capacity and resistance charts furnished showing use of instruments for testing condensers, also measuring resistances up to 100,000 ohms. Eight scale readings of meters may be used separately with the jack terminals provided. Scale readings are 0-60-300-600 D.C. volts, 0-10-140-700 A.C. volts and 0-20-120 milliamperes. A.C. and D.C. filament voltages are accurately measured on the one meter. Strong case with leatherette covering. Attractive. Compact. Size 10¾x3½x8 inches. Shipping weight 15 lbs. **List Price $25.00.**

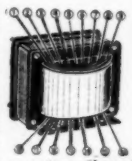
No. 700—READRITE ANALYZER. YOUR PRICE..... $14.70

Flewelling-Dayton SW Adapter

This wonderful instrument connects to any A.C. radio set by putting into tube socket in place of the tube (which must be a type '27, or "heater" tube) the plug which is on the end of its 2-ft. cable; then put tube into tube-socket of adapter. Remove aerial from broadcast set and connect to antenna post on adapter. Special plug-in coil No. 1 covers a wavelength band of 17 to 29 meters; coil No. 2, 27-28 meters; coil No. 3, 47-84 meters. Pins in coil inductances come with the adapter. 5½x7½x4" high, overall. Ship. weight 4 lbs.

No. 1613 — Dayton Flewelling Short-Wave Adapter. List Price, $15.00. YOUR PRICE (without tube).... $4.93

Earl Power Transformers



Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B" and "C" potentials for: two '27's (or screen-grid '24's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's and for '71A's are center-tapped. Size, 3¾ x 3 x 2¾ inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. **List Price, $7.50.**

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Baldwin D.C. Dynamic Speaker

A brand new addition to the famous Baldwin line of speakers. Never before has a speaker of such small size offered such fidelity of response. 9 in. diaphragm, 2500-ohm field winding with 15-ohm voice coil. For use across D.C. line or with field coil acting as filter choke in power supply circuit. Furnished without coupling transformer. Shipping weight, 10 lbs. **List Price, $12.00.**

No. 1513—Baldwin D.C. Dynamic Speaker. YOUR PRICE..... $4.73

Columbia Phonograph Pick-Up

An exceptionally fine phonograph pick-up unit complete with tone arm. Made for Kolster by the famous COLUMBIA organization. Pick-up swings back over arm while changing record. Cushion stop prevents jarring of pick-up head. Handsome bronze finish. An ideal pick-up for home, theatre or auditorium. Brand new merchandise. Shipping weight, 5 lbs. **List Price, $19.75.**

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The new Summer Edition of our greatly enlarged RADIO SERVICE TREATISE has just come off the press. If you liked the Winter Issue, you will like this one a hundredfold. It contains some 75 new hook-ups, circuit diagrams; and some 350 illustrations. **POSITIVELY THE GREATEST BOOK EVER PUT OUT BY ANYONE.** Among the new matters listed are:

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6 MONTHS GUARANTEED NEONTRON TUBES

Sold on a **6 MONTHS FREE REPLACEMENT GUARANTEE BASIS, PROVIDING TUBE LIGHTS!** All tubes are carefully meter-tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY tubes with any other "low priced" tubes—our low prices are possible because we do a VOLUME business!

NEW

Choice	Choice of	Choice	Choice	Choice	Choice
226	112A	245	222	230	235
227	200A-199X	280	240	231	247
171A	120UV-120	171	250	232	
201A	224		281		
63c ea.	69c ea.	79c ea.	1.58 ea.	1.08 ea.	1.50 ea.

Utah Dynamic A.C. Power Speaker—Model 33A

110-volt, 60-cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier; 9 in. high, 9½ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone. **List Price $50.00.**

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NEW! NEW!! Superheterodyne S-W Converter

At last a short-wave converter that converts any broadcast set into a superheterodyne short-wave receiver. Employs three 227 tubes and covers from 20 to 115 meters. No plug-in coils! Coil switch is used to cover all wavelengths. Single dial control, no body capacity, no squeals. This converter has built-in filament transformer to heat the three 227's. All you need to obtain from your receiver is a positive B voltage anywhere from 45 to 180 volts. Voltage is not critical; no molestation of the receiver. So simple a child can operate it. Size 7 x 10 x 5 inches. Shipping weight, 8 lbs. **List Price $25.00.**

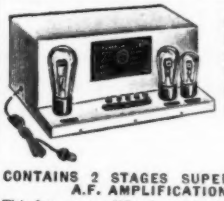
No. 1614—Super Converter (less tubes). YOUR PRICE..... $15.93

High-Voltage Condenser Units

We guarantee these condensers unconditionally. They are ideal for general replacement purposes and can be installed in any new power-pack. All condensers are furnished with 8-inch lengths of tinned "push-back" wire.

600 VOLTS			800 VOLTS		
Cat. No.	Mfd. Capac.	Your Price	Cat. No.	Mfd. Capac.	Your Price
1702	½	$0.25	1706	1	$0.40
1703	1	.30	1707	2	.70
1704	2	.40	1708	4	1.05
1705	4	.60			

Pacent "250" Power Auditorium Amplifier



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Announcement!

OFFICIAL RADIO SERVICE MEN'S ASSOCIATION

EVER since the appearance of the commercial radio broadcast receiver as a household necessity, the Radio Service Man has been an essential factor in the radio trade; and, as the complexity of electrical and mechanical design in receivers increases, an ever-higher standard of qualifications in the Service Man becomes necessary.

The necessity, also, of a strong association of the technically-qualified radio Service Men of the country is forcing itself upon all who are familiar with radio trade problems; and their repeated urgings that such an association must be formed has led us to undertake the work of its organization.

This is the fundamental purpose of the OFFICIAL RADIO SERVICE MEN'S ASSOCIATION, which is not a money-making institution, or organized for private profit; to unite, as a group with strong common interests, all well-qualified Radio Service Men; to make it readily possible for them to obtain the technical information required by them in keeping up with the demands of their profession; and, above all, to give them a recognized standing in that profession, and acknowledged as such by radio manufacturers, distributors and dealers.

To give Service Men such a standing, it is obviously necessary that they must prove themselves entitled to it; any Service Man who can pass the examination necessary to demonstrate his qualifications will be elected as a member and a card will be issued to him under the seal of this Association, which will attest his ability and prove his identity.

The terms of the examination have been drawn up in co-operation with a group of the best-known radio manufacturers, as well as the foremost radio educational institutions.

The following firms are co-operating with us:

GRIGSBY-GRUNOW CO (Majestic), CHICAGO
STROMBERG-CARLSON TELEPHONE MFG. CO., ROCHESTER, N. Y.
CROSLEY RADIO CORP., CINCINNATI, OHIO
COLIN B. KENNEDY CORP., SOUTH BEND, IND.

The schools who have consented to act as an examination board are:

International Correspondence Schools, Scranton, Penna.; Mr. D. E. Carpenter, Dean.

RCA Institutes, Inc., New York, N. Y.; Mr. R. L. Duncan, President.

East Bay Radio Institute, Oakland, Calif.: Mr. T. T. Tonnehilt, Director.

Radio Training Association of America, Chicago, Ill.; Mr. A. G. Mohaupt, President.

School of Engineering of Milwaukee, Milwaukee, Wisc.; Mr. W. Werwath, President.

Rider-Goll Radio School, New York, N. Y.; Mr. John F. Rider, Director.

Radio College of Canada, Toronto, Canada; Mr. J. C. Wilson, President.

Radio Division, Coyne Electrical School, Chicago, Ill.; Mr. H. C. Lewis, President

We shall not attempt to grade the members into different classes. A candidate will be adjudged as either passing or not passing. If the school examining the papers passes the prospective member as satisfactory, we shall issue to him an identification card with his photograph.

If the candidate does not pass this examination the first time, he may apply for another examination three or six months later.

There is absolutely no cost attached to any service rendered by the Association to its members, no dues, no contributions.

If you wish to become a member, just fill out the coupon below and mail it to us. We will send you all the papers necessary to become a member.

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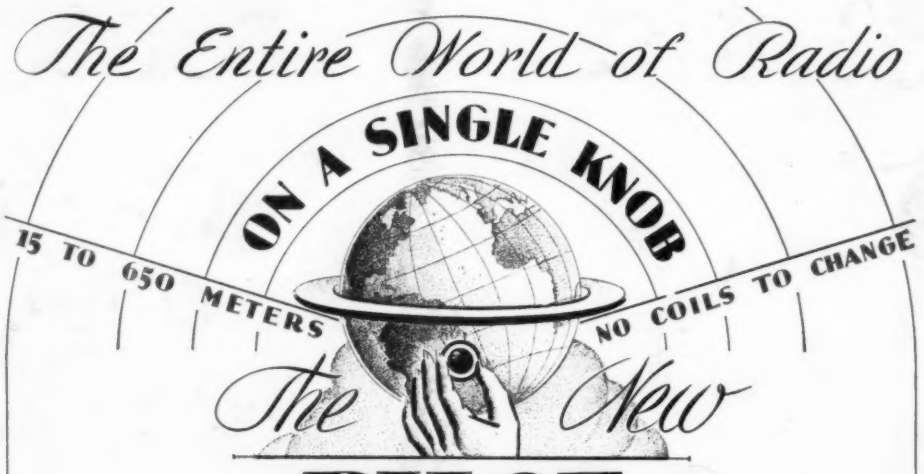

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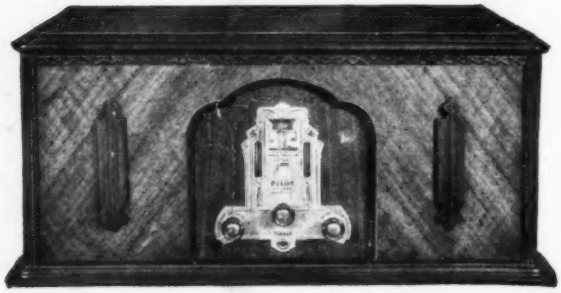

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